

THE EFFECTS OF USING KAHOOT! AS A FORMATIVE ASSESSMENT
IN THE MIDDLE SCHOOL SCIENCE CLASSROOM

by

Alison K. Charbonneau

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2018

©COPYRIGHT

by

Alison Kay Charbonneau

2018

All Rights Reserved

ACKNOWLEDGEMENTS

Research is rarely a solitary process. I would like to thank the individuals, without whom this research project would not have happened: Walter Woolbaugh for his patience, instruction, and valuable feedback, Terrill Paterson for his statistical instruction and attention to detail, the members of my MSSE cohort who offered valuable suggestions throughout the design and writing process, Will Charbonneau for his willingness to help with last-minute editing, and Dwaine Charbonneau for being my primary support, and always giving but never demanding.

TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND	1
CONCEPTUAL FRAMEWORK.....	4
METHODOLOGY	11
DATA AND ANALYSIS.....	17
INTERPRETATION AND CONCLUSION	42
VALUE.....	47
REFERENCES CITED.....	51
APPENDICES	55
APPENDIX A Schedule Of Action Research	56
APPENDIX B Data Colleciton Instruments	58
APPENDIX C Student Likert Survey.....	60
APPENDIX D Mid-Treatment Student Survey.....	62
APPENDIX E Student Interview Questions.....	65
APPENDIX F Observation Instruments	68
APPENDIX G Delayed Cumulative Quiz	71
APPENDIX H Exit Ticket Survey.....	73
APPENDIX I Reasoning for Each Instrument.....	75
APPENDIX J IRB forms	77
APPENDIX K Comparison of Test Score Distribution for Each Treatment...	80

LIST OF TABLES

1. Demographics of Students in the Research Project	11
2. Data Triangulation Matrix	16
3. Range of Struggling Students' Cores after Different Treatments.	39
4. Treatment Schedule	57
5. Measurement Tools for Data Instruments.....	59
6. Exit Ticket Survey Results of Students' Treatment Preferences.....	75
7. Data Collection Matrix	77
8. Comparison of Test Score Distribution	82

LIST OF FIGURES

1. Entire Population Preference for Kahoot!, (N=100).....	20
2. Exit Ticket, Student Preference for Quiz Method Post-treatment, (N=105)	21
3. Likert Survey Results Pre- and Post-research, (N=100).....	22
4. Preference for Discussion and Paper Quizzes Over Kahoot!, (N=100).....	23
5. Preference for No-Score Kahoot!, (N=100).....	24
6. Preference for Team Kahoot!, (N=105).....	25
7: High-achieving Students' Preference For Team Kahoot!, (N=49)	26
8: Struggling Students' Preference For Team Kahoot!, (N=47)	26
9. Students' Preference for Rankings and Scores Kahoot!, (N=100).....	28
10. Mid-treatment, Male Student Preference For Competitive Kahoot!, (N=50).....	29
11. Mid-treatment, Female Student Preference For Competitive Kahoot!, (N=55)	29
12: Mid-treatment Survey, Students Focused Ranking More Than Content, (N=100)	30
13. High-achieving Student Preference For Competitive Kahoot!, (N=59)	31
14. Struggling Students' Preference Or Competitive Kahoot!, (N=46)	33
15. Special-education Student Preference For Competitive Kahoot!,(N=19).....	34
16. Mean of Eight Unit Tests By Treatment, Entire Population, (N=120).....	37
17. Test Scores for All Units By Treatment and Student Sub-groups, (N=120)	37
18. Histogram Students' Test Scores After Competitive Kahoot! Treatment (N=120) ...	38
19. Histogram of Struggling Students' Test Scores After Competitive Kahoot! (N=43). 38	
20: Mean of Eight Unit Tests By Treatment, Struggling Students, (N=43)	39
21: Mean of Eight Unit Tests By Treatment, High-achievers, (N=54).....	41
22: Mean of Eight Unit Tests By Treatment, Females, (N=59)	41

LIST OF FIGURES - CONTINUED

23: Mean of Eight Unit Tests By Treatment, Males, ($N= 61$)	42
24: Comprehensive Test Scores After Six Months, ($N=109$)	43

ABSTRACT

Formative assessment is classroom assessment that occurs before the summative assessment and is used by students to determine their progress towards the learning target, and by the teacher to inform instruction. Black and Wiliam's paper, "Inside the Black Box", provides compelling evidence that formative assessment, properly implemented, is a powerful tool to improve student learning. Research also shows that high-quality formative assessment in the classroom is rare. In search of such assessments this study focused on the impact of using the digital-learning game Kahoot!, in middle-school science classes. According to Kahoots! CEO, more than 50% of all US k-12 students use Kahoot! monthly, and it is growing at a rate of 75% a year, with over 1.6 billion users overall (Kahoot.com, 2018).

By comparing 120 students' engagement with three different modes of Kahoot! — team, competitive, and no-score — to traditional classroom discussion, this study measured the impact of Kahoot! as a formative assessment in a middle school science classroom. Student performance was measured with unit tests, and student engagement and preference were measured with Likert surveys, classroom observations, and student interviews. The results were analyzed to determine the impact of Kahoot! on students of different genders and academic abilities. The results indicate that Kahoot! did not have a significant impact on students' performance as a whole, but public competition did have a statistically significant impact on their preference for the different modes of Kahoot!. After six months, most students remained engaged by Kahoot! and they felt it helped them learn.

INTRODUCTION AND BACKGROUND

The following primary question was addressed during this research: “What is the impact of using Kahoot! as a formative assessment tool in a middle-school science classroom?” This study answered the question by comparing middle school students’ engagement and performance with three different modes of Kahoot! — team, competitive, and no-score — to traditional classroom discussion.

The Setting

Saint Helens Middle School is a public school in a rural part of northwest Oregon that is bordered by the Columbia River to the east and the Coastal Mountains to the west. The middle school draws from a poor socio-economic area whose economy was natural resource-based until the mill closed a few years ago. The town is slowly transitioning to a bedroom community for Portland, Oregon.

Currently 49% of the students are on free-and-reduced lunch according to school administrators. Saint Helens Middle School is 84% Caucasian and has 224 seventh-graders, 120 of which participated in this research project. Having come from an enclosed classroom with one teacher, to a middle-school model where they rotated through six periods per day, many of the students in this study struggled with the rigor of middle school. This was also the first year they participated in a science course, so they began the year with little formal science education.

Historically, the middle school’s standardized tests scores in science were higher than the state average (“Dropout rates fluctuate in St. Helens,” 2016).

but only 73% of the middle school students go on to graduate from high school, and fewer than 10% of the St. Helens' High School graduates are college ready according to US News and World Report/Education.

The Problem and Research Questions

In response to students' struggles and low standardized test scores at the high school level, the district's staff was trained in quality assessment practices. As part of my training I chose to focus on formative assessments, which a growing body of research was showing could have a significant impact on student learning (Black, 2001). Formative assessments are used prior to summative assessments, to gauge student understanding and inform instruction. They should also provide effective feedback to students, and actively involve them in their own learning. Unfortunately, research shows that high-quality formative assessments in the classroom are rare (Wiliam, 2018).

During the past two years I have made a concentrated effort to find and use effective and engaging formative assessments. This resulted in fewer unexpected scores on summative assessments, but I still felt there was a population of silent and less articulate students that went unnoticed and were not receiving the help they needed. There were still times I mistook individual mastery for class mastery. With 120 students and little time to read papers or give written feedback, I needed a fast, effective, engaging, and paperless formative assessment. One that would catch the lingering learning gaps and misconceptions of all my students.

While searching for that high-quality formative assessment a colleague suggested I try using Kahoot!, which was an engaging gaming-student-response system (GSRS). It was easy to use, free, and gave instant feedback in the form of a response graph after each

question. The results of the quiz could be downloaded to track the progress of individual students, even the ones that didn't write. In its default mode Kahoot! motivated students through catchy music, points, timing, and the posting of the top scorers after every answer, this mode could be played in teams or individually. Kahoot! had another mode that did not include the students' scores, but still created a game-like environment with its music, timed questions, and positive messages.

Soon I was using Kahoot! as one of my primary formative assessments, but it took time to log in to the quiz, and the kids got so caught up in the competitive nature of the "game" that I was not sure if it was just an engaging distraction, or an effective learning tool. Also, after a very outspoken autistic student refused to participate in Kahoot!, I began to wonder how the public competition aspect of it affected different sub-groups of students. These uncertainties led to my action research question: What is the impact of using Kahoot! as a formative assessment tool on the engagement and performance of middle-school science students?

This primary question raised additional sub-questions that affected the implementation of the treatment:

1. What is the effect of Kahoot! on student engagement and behavior?
2. What is the impact of competition on students of different genders and academic abilities?
3. What is the impact of Kahoot! on the test performance of students of different genders and academic abilities?

4. What is the impact on the teacher when Kahoot! is used as regular formative assessment?

CONCEPTUAL FRAMEWORK

Kahoot! is considered a game-based student response system (GSRs). To research the value of using GSRs as formative assessments, I focused on studies that explored formative assessment, student response systems, gaming response systems, digital quizzing, competitive and cooperative learning, the development of multiple choice questions, and quizzing frequency.

Formative Assessment

Formative assessments have been a part of effective teaching practices since the late 1960s and, it could be argued, since the time of Socrates (Abrahamson, 1999; Roos & Hamilton, 2005). Originally, they were informal assessments used by teachers to assess the effectiveness of their curriculum and to guide instruction. In 1998, Black and Wiliam performed a comprehensive study of formative assessment research and found that the typical effect sizes of the formative assessment experiments were between 0.4 and 0.7. These effect sizes are larger than most of those found for educational interventions. Black and Wiliam argued that self-assessment by pupils was an essential component of formative assessment, and the term should be expanded to include feedback to students. Now formative assessments are understood to be dynamic processes, used by teachers and students, to provide ongoing feedback so teachers can modify their instruction, and students can improve their learning (Black, 2001).

Student Response Systems

In the late 1970s, to include students in their learning assessment, post-secondary educators started using Student Response Systems, or SRSs, as formative assessment tools. The SRS allowed students to click in their responses to multiple-choice questions, using remote devices, so the results could be instantly compiled and presented to the class in histogram form, giving students and teachers immediate feedback on the effectiveness of the instruction (Abrahamson, 1999; Bessler, 1971).

Many reports have been published on the impact of SRSs on short- or long-term retention, but the results have been mixed. Learning gains were not observed when SRSs were used for stimulus response-type learning, but positive gains in student learning were observed when SRSs were used in conjunction with active-learning strategies and immediate feedback (Cleveland, Olimpo, & DeChenne-Peters, 2017; Conoley, 2007). In recent years a new response system, the game-based student response system, GSRS, has become more common in schools. These response systems include gaming elements such as music, points, and engaging visuals (Wang, 2016). Kahoot! is a popular GSRS and according to the 2018 Kahoot! website, Kahoot! is being used monthly in over 50% of all United States k-12 classrooms (<https://techcrunch.com/2018/01/18/education-quiz-app-kahoot-says-its-now-used-in-50-of-all-us-classrooms-70m-users-overall/>), (<https://medium.com/inside-kahoot/kahoot-reaches-1-billion-players-db5664c1d1b7>) .

Gaming

“No compulsory learning can remain in the soul.... In teaching children, train them by a kind of game, and you will be able to see more clearly the natural bent of each. ”

(Plato, The Republic, Book VII)

“Sure they have a short attention span — for the old ways of learning!”

-Edward Westhead, former Dartmouth professor (Prensky, 2001, p. 1)

Using games to engage students in active learning is not new; what is new is the format of the games and the attention-span of the students for traditional teaching methods. Digital game use in education has been increasing as educators try to create fun and engaging learning environments for 21st century students. Unsurprisingly, a year-long study that included over 500 teachers found the majority confirmed that motivation is significantly greater when digital games are integrated into the educational process (Joyce, 2009). What is not clear is if there is an improvement of content retention. There is much theoretical support for the use of games in the classroom, but there is less empirical support (Erhel, 2013). This literature review provides an overview of the theoretical and empirical evidence behind the claims that GSRs provide a better learning environment for the student and are authentic and relevant assessments of student learning.

Today’s digital games are not the quiet, teacher-paced, games of the past, nor are today’s students willing to engage in those games. Marc Prensky, a proponent of digital game-based learning, believes today’s learners have been deeply formed by computer and video games and this, he argues, has changed the way they think, learn, and process information (Prensky, 2001). He is not the only one that believes in teaching through games:

digital game-based learning has taken root in the educational system, as exemplified by a New York City charter school, Quest to Learn, which is organized specifically around the idea that digital games are central to the lives of today's children and are powerful tools for intellectual exploration (Corbett, 2010). Concerns over the need to reform the educational system to prepare students for a technology-driven, interconnected and competitive world are becoming common news (Jenkins, 2009). As Bill Gates (2005) noted in his address to the National Educational Summit on High Schools, "Training the workforce of tomorrow with the high school of today is like trying to teach kids about today's computers on a 50-year-old mainframe. It's the wrong tool for the times" (p. 3). It is not only *what* students need to learn that is shifting, but also *how* they learn.

Supporting Theory and Research for Gaming Student Response Systems

Current educational theories also support gaming with their focus on *active learning*, the idea that students need to be engaged and put at the center of the learning experience, so that they are no longer "passive vessels," but "active participants" in their own education (Iverson, 2005; Quinn, 2005). The constructivism theory, which suggest humans construct knowledge and meaning from their experiences, also provides a foundation for the use of gaming as a method of learning (Dudduan, Nirat, & Sumalee, 2015; Jong, 2010; Vygotsky, 1980).

Recent research shows that digital quizzes can teach and reinforce content better than traditional methods of paper and pencil (McDaniel, Thomas, Agarwal, McDermott, & Roediger, 2013), and this is true whether assessments are selected-response or short-answer (Carnegie, 2015). Gaming student response systems, like Kahoot!, have also been used

successfully to enhance clinical judgment and knowledge retention in nursing schools (Lane, 2011), but some research suggests digital quizzes do not outperform traditional methods of textbook reading and note-taking in *long-term* retention assessments (Rondon, 2013).

Regardless, there is a growing body of evidence that retrieval practice (repeated quizzing) in the classroom does boost academic performance (McDaniel, Agarwal, Huelser, McDermott, & Roediger, 2011)

Currently, most high-stakes summative assessments are selected-response, so the GSRS format is appropriate, although those tests may change in the future with the adoption of the Next Generation Science Standards which emphasize science skills and practices such as science inquiry, explanation, argumentation, and communication as assessment tools (Standards, 2012). If used correctly, GSRS quizzes can work as platforms for explanation, argumentation, and communication as students and teacher discuss and evaluate the students' GSRS responses.

Other variables, besides the display of results and the question format, that separated the GSRS from my traditional formative assessments were the music, timed questions, and competitive ranking. There have been many studies on the effects of studying with music, and on the long-term effect of musical training on cognitive function, but the research that is most applicable in this case is the study done specifically on the effect of the music and points in Kahoot!. Wang and Lieberoth polled 593 university students after they played Kahoot! with music and points, music and no points, no music and points, and no points and no music. Their results showed that audio statistically improved concentration ($p < 0.0001$), and that audio increased the perception of learning (98% with audio, 90% without audio).

Students also reported trying harder on the quiz when there was music ($p = 0.0083$) (Wang, 2016).

Kahoot! questions are also timed, but according to Glass (2009), if students are given more than 90 seconds to change an answer they rarely do, so I set the game-response time at 20 seconds for recall questions, and 60 seconds for more analytical questions.

Competition vs. Cooperative Learning

Cooperative learning has a strong following and proven results (Slavin, 2014), but some research indicates that competition rather than cooperation can drive digital participation and improve learning (Hwang & Arbaugh, 2009). The cooperative learning model of forming teams that compete in a tournament has also been shown to significantly improve learning outcomes (Nadrah, Tolla, Ali, & Muris, 2017).

Prior to this research, I was reluctant to use Kahoot!'s competitive options because I felt they detracted from the learning, but research shows that the risk that is inherent in competition is a strong incentive to learn and can also make it fun. In one study of 9-10-year-old students ($N=448$), follow-up quiz results were collected one week after a science workshop, where students learned in either a 'Control', 'No risk', or competitive 'Risk' condition. The students in the 'Risk' group retained more knowledge than the 'Control' or 'No risk' groups. The average scores (including \pm confidence levels) for all pupils in the 'Control,' 'No risk' and 'Risk' conditions were 5.80 ± 0.33 , 5.70 ± 0.27 , and 6.30 ± 0.26 , respectively. The average scores for boys in the 'Control,' 'No risk' and 'Risk' groups were 5.65 ± 0.55 , 5.60 ± 0.36 , and 6.38 ± 0.36 , respectively (Devonshire, et. al, 2014).

To determine the best combination of competition and cooperation for increased learning outcome I compared Kahoot! in its competitive mode to its team mode and analyzed the different effect it had on students of different genders and abilities.

Writing Valid Multiple-Choice Questions

A key factor in determining the effectiveness of repeated game quizzes is the quality of the questions. Science can be difficult for middle-school students because of the quantity of scientific vocabulary, so vocabulary quizzing is a valid use of GSRS. However, instruction should go beyond the mere memorization of fact; it should also teach students to apply, analyze, and synthesize knowledge. Multiple-choice questions can do this if they are carefully thought out. For instance, questions that make an assertion and ask students to select a supporting reason (ARQs) are at the top of Bloom's taxonomy (Williams, 2006). During this research project I wanted to scaffold my quiz questions to lead students to more complex thought, so they could answer assertion and response questions. Scaffolding the questions would also allow me to use the GSRS to introduce new material as well as a review of past information. Making sure my Kahoot!s had clear goals and provided immediate and constructive feedback allowed me and my students to adapt to the feedback, which made them well-designed formative assessments according to Black and Wiliam's standards (Black, 1998; Kang, McDermott, & Roediger, 2007).

Quizzing Frequency

Research supported frequent, low-stakes, quizzes (Reisel, 2013) but a study by McDaniel found that using frequent quizzing and skipping test review was counter-productive (McDermott, Agarwal, D'Antonio, Roediger, & McDaniel, 2014).

METHODOLOGY

Introduction

To determine the impact of Kahoot! as a formative assessment students' engagement, perception of learning, and content retention was measured with: interviews, surveys, pre- and post-unit tests, classroom observations and a comprehensive Kahoot!. The impacts of the three different modes of Kahoot! on male, female, high-achieving, and low-achieving students, were also measured and analyzed.

One hundred and twenty 7th-grade students participated in the study. Table 1 shows a breakdown of the student population into sub-groups.

Table 1
Demographics of Students in the Research Project

	All Students		Special Education		Talented and Gifted		English Language Learners		504 Learning Accommodation	
Total	120		24		6		4		5	
Gender	F 59	M 61	F 11	M 13	F 4	M 2	F 1	M 3	F 0	M 5
Highly Motivated	25	11	1	0	4	2	0	0	0	0
Average Motivation	21	32	5	4	0	0	1	3	0	2
Unmotivated	13	18	5	9	0	0	0	0	0	3

Note. Highly Motivated=redo work and turn in missing work, Average Motivation=don't retake tests but do turn in missing work, Unmotivated=don't turn in missing work or retake tests, ($N=120$).

The Kahoot! Treatment

Kahoot! is a free game-based response system that can be played by a whole class at one time. Multiple-choice questions are projected on a screen and students can respond with any device that connects to the web. Catchy music plays between questions and once

the question launches a timer shows students how long they have left to answer. Once the time is up a histogram of the responses is projected on the screen. Students' devices show a green screen with a ✓ if they selected correctly and a red screen with an X if they selected the incorrect answer. In the competitive modes of Kahoot! students' rank and score show up on their screen, and the classroom screen projects the user names of the top ranked students. Students are ranked by speed of selection and accuracy.

Kahoot! has three quiz modes: team, competitive, and no-score. This research study compared each Kahoot! mode against the other and against a comparison group, that consisted of a traditional classroom discussion and was referred to as the Paper group. For ease of reference the three different Kahoot! treatments were called Competitive Kahoot!, Team Kahoot!, and No-Score Kahoot!. Competitive Kahoot! was the original form of Kahoot! and it ranked students individually. Team Kahoot! was played in teams of two and students had 20 seconds to discuss the question before they could answer. No-Score Kahoot! was just like Competitive Kahoot! except the score function was turned off, so students didn't receive points for answering but they were still ranked by speed. For Kahoot! quiz examples go to <https://kahoot.com/explore-games/>.

The Schedule

This research study lasted twelve weeks beginning in the fall of 2017. Prior to the treatment students played two Kahoots! to become familiar with the login process and the structure of the game. . Two weeks before the treatment the first student interviews and surveys were conducted. Once treatment began the four classes of life science students were rotated independently through the four treatments equally after every unit. During the

first unit the first class participated in a classroom discussion as its formative assessment, the second class played Competitive Kahoot!, the third class played Team Kahoot! and the fourth class played No-Score Kahoot!. The units lasted approximately two weeks and the students took a practice quiz at the beginning of the unit and a review quiz just before the summative test (McDaniel et al., 2011; Roediger, 2011). The treatment lasted through eight units, beginning in October of 2017 and finishing in March of 2018. A schedule of the research study can be found in Table 6 of Appendix A.

The Instruments

The instruments used for this research project include the qualitative instruments used to measure students' engagement, preference for the different treatments, the impact of competition, and perception of learning. The quantitative instruments were used measure students' learning, treatment preference and engagement. A summary of the data collection tools and the questions they addressed can be found in Appendix B.

Qualitative Instruments

The qualitative instruments consisted of pre-, mid- and post-student surveys, pre-, mid- and post student interviews, and a teacher's journal.

A Likert survey, with scales that addressed each of the research questions, was administered pre-and post-treatment (Appendix C). The survey was delivered as a Kahoot! survey with Strongly Agree, Agree, Disagree, and Strongly Disagree as answer choices. The questions measured: student's engagement with science, their feelings about the scoring and ranking in Competitive Kahoot!, their preference for the different treatments, their perceptions of learning with Kahoot!, and any anxiety they felt during Kahoot!. A

more in-depth, short-answer, Mid-Treatment Survey was administered 4 months into the classroom research project (Appendix D). Students were given one 40-minute class period to fill it out.

The student interview (Appendix E) began with the questions from the Likert survey and followed up with four or five probing questions. Nine students were interviewed three times throughout the study. To select the interviewees, students were sorted into three academic performance groups – high, average, and low – and additionally sorted into three motivation groups. An interviewee was then randomly chosen from each of the nine groups. The exception to this were the high-achieving students because there were no unmotivated high-achieving students.

All three instruments were piloted before the research and I received feedback on the questions' validity from Walter Woolbaugh, my Implementation of Action Research professor, and the other 7th grade life science teacher in Saint Helens Middle School. Finally, a teacher journal was kept measuring the impact of the study on the teacher and the classroom instruction.

Quantitative Instruments

An observation form, modeled after the Charles Darwin University School of Education Recording Sheet for Student Engagement, was used to measure student engagement and behavior (Appendix F). My student teacher observed all the classes twice during the treatment period. The first time he observed six students per class. For each class, two students were selected randomly from each of the three different motivation

categories. The second time he observed from the back of the classroom, so he could see all the students' screens and mark down any off-task behavior.

Each unit began with a pre-test that was the same as the unit's summative assessment. Prior to each unit test the students played one practice Kahoot! and one review Kahoot!. The results of the eight unit-tests were sorted according to the treatment received and recombined to determine the effect of each treatment on the different populations of students. The mean and mode were calculated from the scores, and the outliers were found by adding and subtracting two standard deviations from the mean. Box-plots and histograms were plotted to analyze the effect of the treatments on student performance. The unit tests were aligned to NGSS standards and had been previously used by me and the other 7th grade science teacher.

To measure content retention a Kahoot! quiz was developed using two questions from each of the unit tests(Appendix G). The quiz was given one month after the last unit test, which meant the material from the beginning of the treatment had not been reviewed for 5 months. Since all four classes performed similarly on the unit tests it was assumed that although the beginning material might not be remembered as well, no treatment would be at a disadvantage. This test was developed as a quick measure of retention and was not validated.

To measure student's long-term attitude toward the different treatments, an Exit Ticket survey was given one month after the research project was completed (Appendix H). The survey simply asked the students to rate the four treatments in order of preference.

Data Triangulation Matrix

The data collection instruments used during this research project are summarized below in Table 2. A more detailed data collection matrix, along with the reasoning for each collection instrument, can be found in Appendix I.

Table 2
Data Triangulation Matrix

Research Questions	Data Source 1	Data Source 2	Data Source 3
<i>Primary Question:</i> What is the impact on student engagement and performance when Kahoot! is used as a formative assessment? .	Pre- and post-unit, tests and a cumulative quiz	Classroom observations	Pre-, mid-, and post-treatment, student interviews and surveys
<i>Sub-Questions:</i> 1. What is the impact of Kahoot! on students' engagement?	Pre-, mid-, and post-treatment, student surveys	Classroom observations	Pre-, mid-, and post-treatment, student interviews
2. What is the effect of competition on sub-groups	Pre- and post-unit tests and a cumulative quiz	Classroom observations	Pre-, mid-, and post-treatment, student interviews and surveys
3. What is the impact of Kahoot! on students' learning?	Pre-, mid-, and post-treatment, student surveys	Pre- and Post-Unit Tests and a Comprehensive Kahoot! Quiz	Pre-, mid-, and post-treatment, student interviews
4. What is the impact of Kahoot! on teacher's motivation and enthusiasm for teaching	Teacher's reflection journal	Classroom observations	Pre-, mid-, and post-treatment, student interviews and surveys

This research project was exempt from a full IRB review because it presented the lowest amount of risk to subjects, and data were reported without identifiers (Appendix J).

DATA AND ANALYSIS

The purpose of this classroom research project was to answer the following research question , “What is the impact on student engagement and learning when Kahoot! is used as a formative assessment in a middle-school science classroom?”

Student Engagement

To answer this question I started with the first sub-question, “What is the impact of Kahoot! on students’ engagement?” The following data collection tools were used to answer this question: Pre- and Post-Likert Surveys, a Mid-Treatment Written Survey, a delayed Exit-Ticket Survey, Pre-, Mid- and Post Student Interviews, and two Classroom Observations.

Classroom Observations of Engagement

The classes were observed by a student-teacher twice during the project: once after 11 weeks of treatment , and once after 14 weeks of treatment. The observations showed that student engagement differed depending on the form of Kahoot! that was being played.

Traditional classroom discussions showed the least off-task behavior towards the end of the treatment period (20% at 11 weeks, 4% at 14 weeks). That may have been because the off-task behavior stopped when the teacher’s attention shifted to the distracted students, or because the off-task behavior was more covert in the relatively quieter environment.

Off-task behavior during the traditional classroom discussions consisted of whispering and drawing. It is hard to know if students were fully engaged during this time because as one student pointed out, “A lot of kids zone out during discussions,” and this might appear as on-task behavior.

No-Score Kahoot! had the highest percent of off-task behavior towards the end of the treatment period (14% at 11 weeks, 24% at 14 weeks). No-Score Kahoot! off-task behavior changed from talking and teasing to primarily online usage. Students opened multiple websites while playing Kahoot! and were online during teacher explanations but switched screens when it was time to answer the question. Teacher's journal entries indicated less enthusiasm when No-Score Kahoot! was played compared to other Kahoot! modes.

Competitive Kahoot! had the least off-task behavior of the three Kahoot! treatments, and the off-task behavior decreased over time (23% at 11 weeks, 15% at 14 weeks). Off-task behavior included surfing online, talking, or dancing, while waiting for the answer to appear. Students were always focused when the question first appeared on the screen.

The Team Kahoot! treatment had the greatest change in behavior over time (2% at 11 weeks, 22% at 14 weeks). It is structured so that there is a 20-second wait time for partners to discuss the question before they can select an answer, and this is when the off-task behavior occurred. Unsurprisingly, talking and web-surfing were highest when students chose their own partners. High-achieving students that answered quickly, and low-achieving boys that were paired together, were the students most likely to be on other websites between questions. A unique misbehavior that occurred during Team Kahoot! was the incessant clicking of the mouse during the 20-second wait time. Students would answer quickly and then repeatedly click the mouse in order to be first to answer.

Another issue unique to Team Kahoot! was the pairing of students. Depending on the personality of the students, high-ability students could take over the decision making and cause the low-ability students to withdraw, *or* valuable discussions could occur to both

students' advantage. One enthusiastic supporter of Team Kahoot! was an autistic student who explained, "Team Kahoot! is great! It gives people a chance to talk about it, and think about it, and make a decision. But some kids don't listen to their partners, so it's not good for them."

Casual observation indicated that student engagement remained at its highest if misconceptions were addressed quickly, and only questions that most students missed were discussed during the game. After five months of playing Kahoot! once or twice a week, Competitive Kahoot! had the highest student engagement at 85% compared to Team Kahoot! at 77% engagement and No-Score Kahoot! at 72% engagement.. During classroom discussions 96% of students were looking at the teacher, but it was difficult to tell if they were engaged.

Treatment Preference Measured by Surveys and Interviews

Results from student interviews and surveys showed students' preference for Kahoot!, over traditional classroom discussions and quizzes, increased from 65% to 85% during the research project (Figure 1).

Preference for all Kahoot! Modes Over Classroom Discussions

Prior to the start of the treatment, students were introduced to Kahoot! with two Kahoot! quizzes before they took the pre-research Likert survey. The survey results showed 65% of the students preferred Kahoot! quizzes over a classroom discussions and paper quizzes. Three months later, after playing Kahoot! once or twice a week, the mid-treatment survey results showed a 92% preference for Kahoot!. A month later that preference dropped

to 75%. The drop in popularity may have been due to more difficult content, or because the novelty of Kahoot! wore off after playing Kahoot! once or twice a week for 4 months.

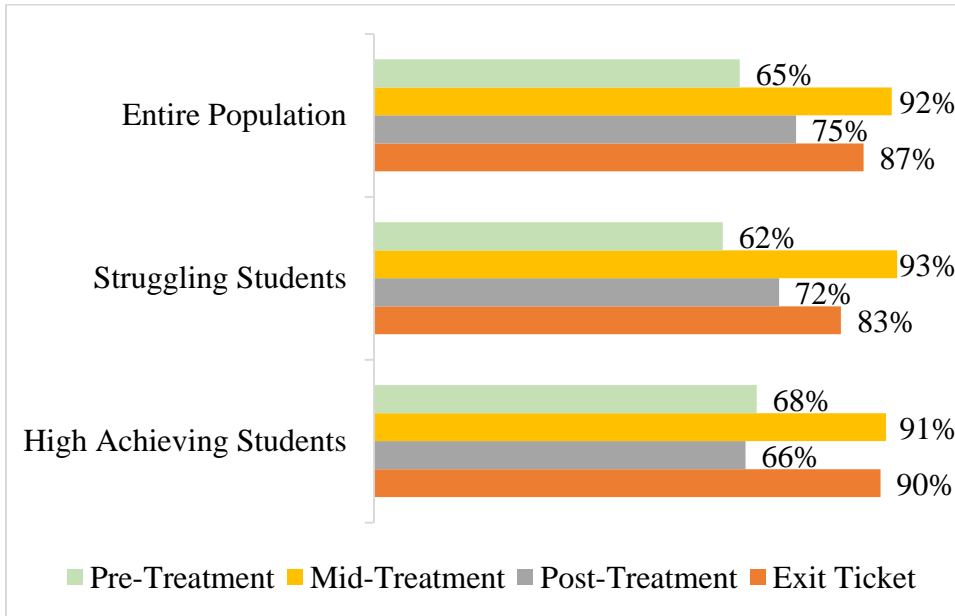


Figure 1. Preference for Kahoot! over time, (N=100).

Once the research project was completed, there was a month-long break from Kahoot! while a student-teacher taught the class. At the end of the month students were once again asked to rank their quiz preference on an Exit Ticket Survey (Figure 2). This time 87% of the students preferred Kahoot! So, preference for Kahoot! increased from 65% to 87% after 4 months of playing it once or twice a week, and the preference for it peaked at three months and dropped by four months. Dividing the exit ticket results into student sub-groups shows that different populations of students had different preferences for the type of Kahoot! they preferred (Appendix H).

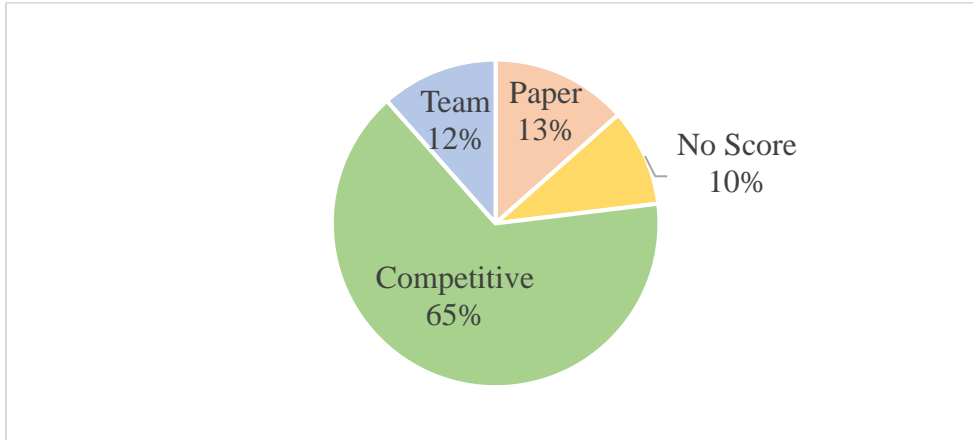


Figure 2. Student preference for quiz method on the Exit Ticket Survey, ($N=105$).

Although there are some indications that continual use of Kahoot! may cause a lessening of enthusiasm over time, Kahoot!'s popularity remained strong throughout the research project.

Mid-Treatment Interviews indicated that students still liked the game aspect of Kahoot! even after three months of playing it, "I like Kahoot! because it is very social and gives encouraging messages." Likert surveys also showed that anxiety while playing Kahoot! dropped by 13% as students became used to the timer and the posting of scores (Figure 3).

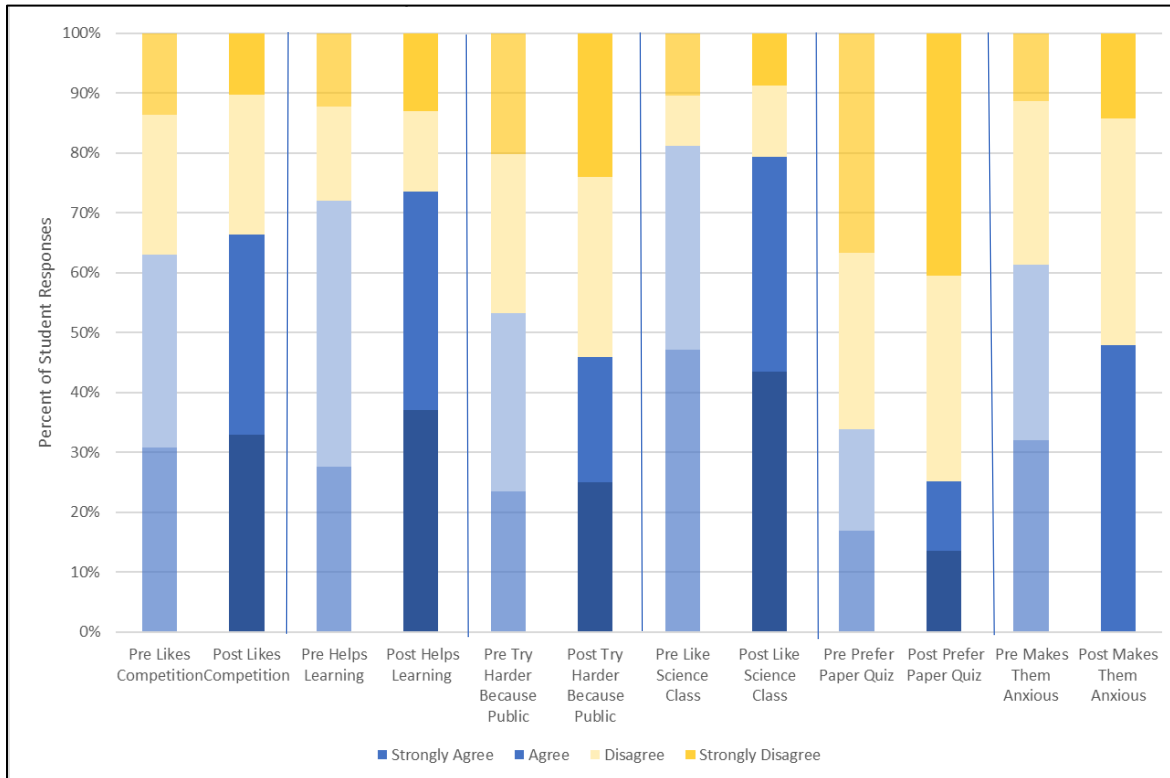


Figure 3. Likert survey of students' attitudes about Kahoot! pre- and post-research, (N=100).

Class Discussion and Paper Quiz Preference

Although preference for the traditional classroom discussion and paper quizzes increased between mid-treatment and the end of the study, it was still less popular than Competitive Kahoot!. The Exit Ticket survey results showed that students preferred classroom discussions over Kahoot! 8% of the time (Figure 4). Those that preferred classroom discussions gave two reasons for liking them: better variety and depth of topic or, most often, the class was quieter and more serious. "I like classroom discussions more because they can be more random and interesting and not just about what the Kahoot! was about," "As much as Kahoot helps, I prefer labs, hands-on, and taking my own notes on things because it's quieter and more serious." A few high-achieving males found the

classroom discussions boring and said they would rather be playing Competitive Kahoot!: “I like discussions during Kahoot! because it makes it more fun.”

The struggling students’ preference for classroom discussions was 18% compared to high-achieving students preference of 10%. The theme in was the same regardless of academic ability, “I prefer the paper quizzes because they aren’t timed and it’s quieter, so I get to think about the answer” (Figure 4)

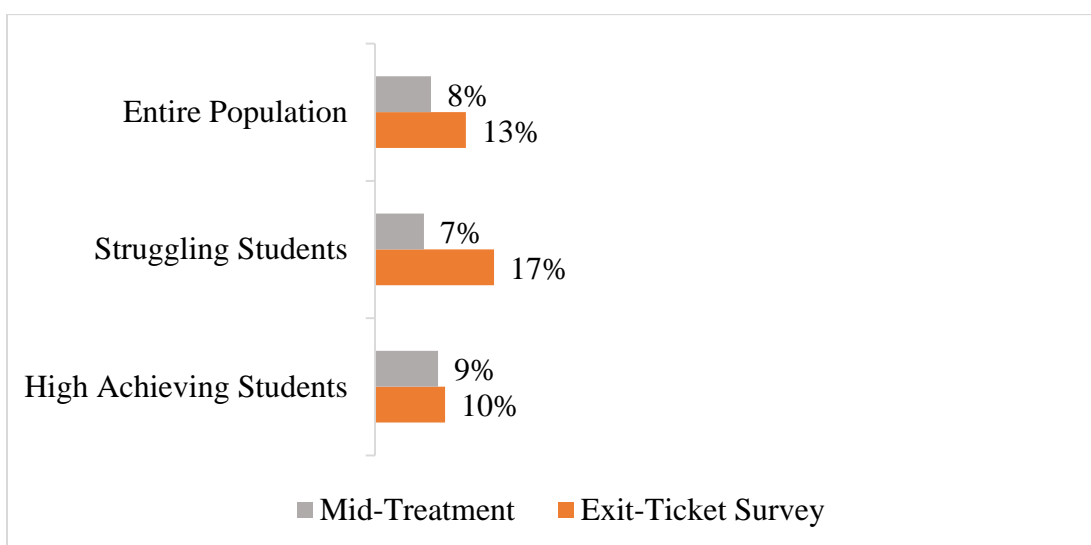


Figure 4. Student preference for discussion and paper quizzes over Kahoot!, (N=100).

No-Score Kahoot! Preference

No-Score Kahoot! did not appeal to most students, especially the high-achieving students. In the final Exit Ticket Survey not a single high-achieving boy preferred No-Score Kahoot! over the other treatments. They felt the ranking made them work harder and they preferred to see how they compared to others, and if they were prepared for the test: “I like the rankings because it pushes me to do better at the questions. It makes me want to get all of the answers right, so I can get 1st place,” and “I like points better so I know how I am doing in science” (Figure 5). The quieter, high-achieving students of both genders preferred No-

Score Kahoot! because as they explained, “I like it better when there aren’t rankings, so people don’t brag. I don’t like to hear people say what place they got.”

Thirty-six percent of the struggling students liked the reduced pressure of No-Score Kahoot!: “I prefer to play without rankings because there are a lot of hard questions,” and “I like it better when there aren’t any points, so it doesn’t make me so nervous” (Figure 5).

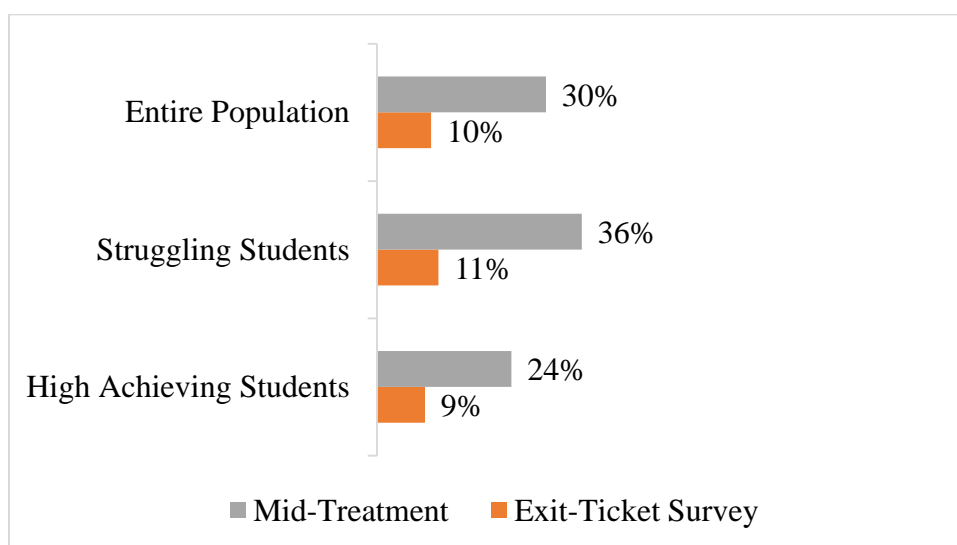


Figure 5. Student preference for No-Score Kahoot!, ($N=100$).

Team Kahoot! Preference

Team Kahoot! was more popular with struggling students than it was with the rest of the students (Figure 6). During the mid-treatment interview a chronically absent girl explained, “It’s better when you do Team Kahoot! because you’re working together and you may learn a little more from your teammate. It’s not good for your brain to be alone.” Another quiet female said, “It’s easier and you can work together, and it doesn’t make me so tense.” Two boys with failing grades explained it like this: “I like teams because you both get to think and help each other,” and “I like teams because if your team wins you feel more happy.”

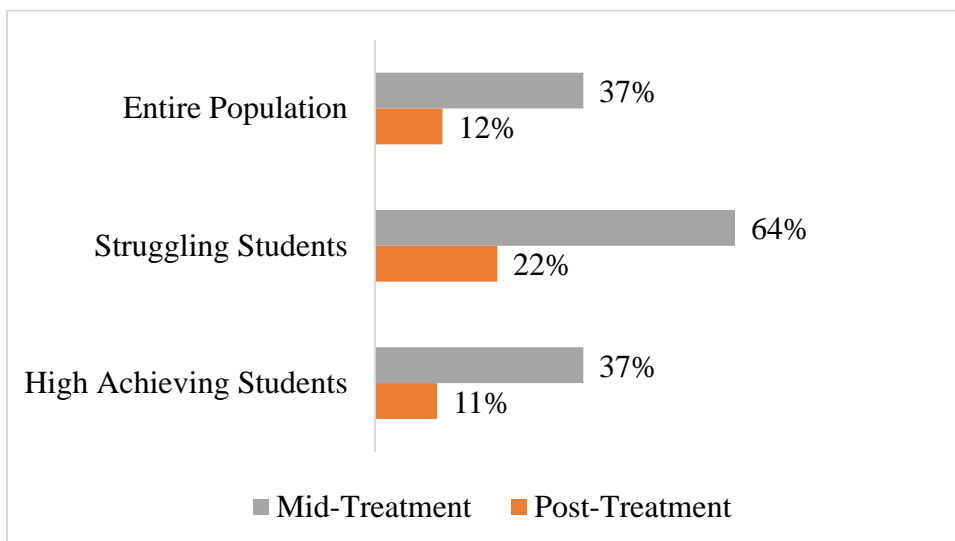


Figure 6. Student preference for Team Kahoot!, ($N=105$).

Team Kahoot! was not popular with most high-achieving students. High-achieving students preferred to play Kahoot! on their own, and like all students, the longer they played Team Kahoot! the less they like it (Figure 6). On the Exit Ticket Survey, none of the high-achieving boys chose Team Kahoot! as their preferred treatment, and only nine percent of the high-achieving girls chose it as their first choice. The three high-achieving girls that chose Team Kahoot! as their preferred treatment were quiet and liked to help their teachers and the librarian. The mid-term written survey, and student interviews, revealed high-achieving students did not like Team Kahoot! because they wanted to know how they would score on their own and they did not like having to discuss the answers with their partners: “I do not like it when we play in teams because then not everybody's voice might be heard,” “Sometimes it is harder to get the person’s answer before the time, or to agree on an answer,” “I don't like team play because I like to think for myself, by myself. I want to see how good I am.”

By mid-treatment there was a significant difference between high-achieving and struggling-students' preferences for Team Kahoot! (Figures 7-8). The Mann Whitney p-value was 0.0113 rendering the difference as significant at $p < 0.05$.

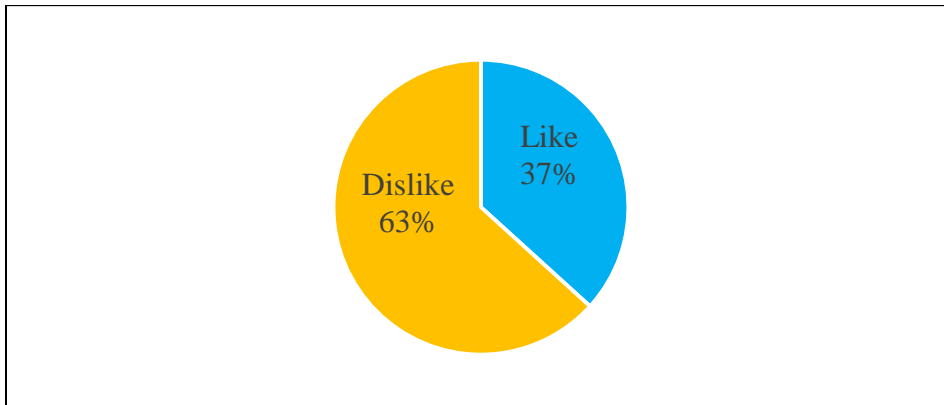


Figure 7. High-achieving students' preference for Team Kahoot!, ($N=49$).

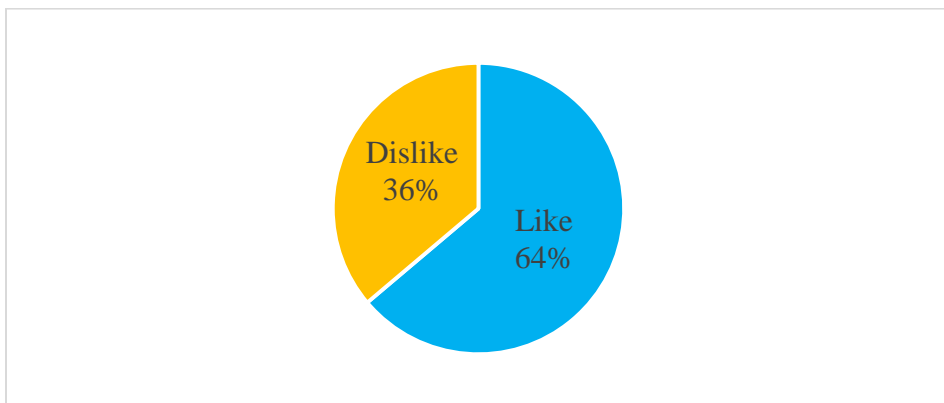


Figure 8. Struggling students' preference for Team Kahoot!, ($N=47$).

By the end of the study the preference for Team Kahoot! had decreased from 64% to 22% among struggling students, and from 37% to 5% among high-achieving students. The drop in the popularity of Team Kahoot! may have been because of the continual pairing of struggling students with high-achieving students. As students became accustomed to Team Kahoot! pairing them became more difficult. When students chose their own partners, they said it was more enjoyable, but off-task behavior increased especially among low-achieving

boys. I usually paired high-achieving students with struggling students because that is how they are seated in my classroom, but more assertive, high-achieving students, began to take over the Chromebooks and the low-achieving students were often sidelined. Once during a Team Kahoot! a special-education student that was paired with an assertive, high-achieving girl, put his head down and slept. By the end of the treatment even struggling students preferred Competitive Kahoot! over the Team Kahoot! treatment (Appendix H).

The Effect of Competition

A second sub-question of this research project addresses the effect of Competitive Kahoot! and public competition in the classroom, “What is the effect of public competition on students of different genders and academic abilities?” Two Likert surveys (pre- and post-research), three student interviews (pre-, mid- and post-research), a written, mid-research survey, eight unit-tests, a delayed comprehensive Kahoot! quiz, and a delayed exit-ticket survey, were used to measure the effect of the public competition in Competitive Kahoot!.

Entire Populations’ Preference for Competition

Understanding the competition results can be confusing because there were two Kahoot! treatments that included competition – Team and Competitive Kahoot!. When describing results that referred to rankings and scores, without making a distinction between Team and Competitive Kahoot!, the term rankings will be used to describe the competition. When describing results that make a distinction between team and individual competition the terms Team and Competitive Kahoot! will be used.

Throughout the five-month research project students preferred to see their rankings, either as a team or as an individual, over no scores at all. The preference increased over time

from 63% to 77% (Figure 9). At the end of 5 months of playing Kahoot! once or twice a week, 65% (Figure 6) of the students preferred Competitive Kahoot! which publicly showed individual scores (Appendix H).

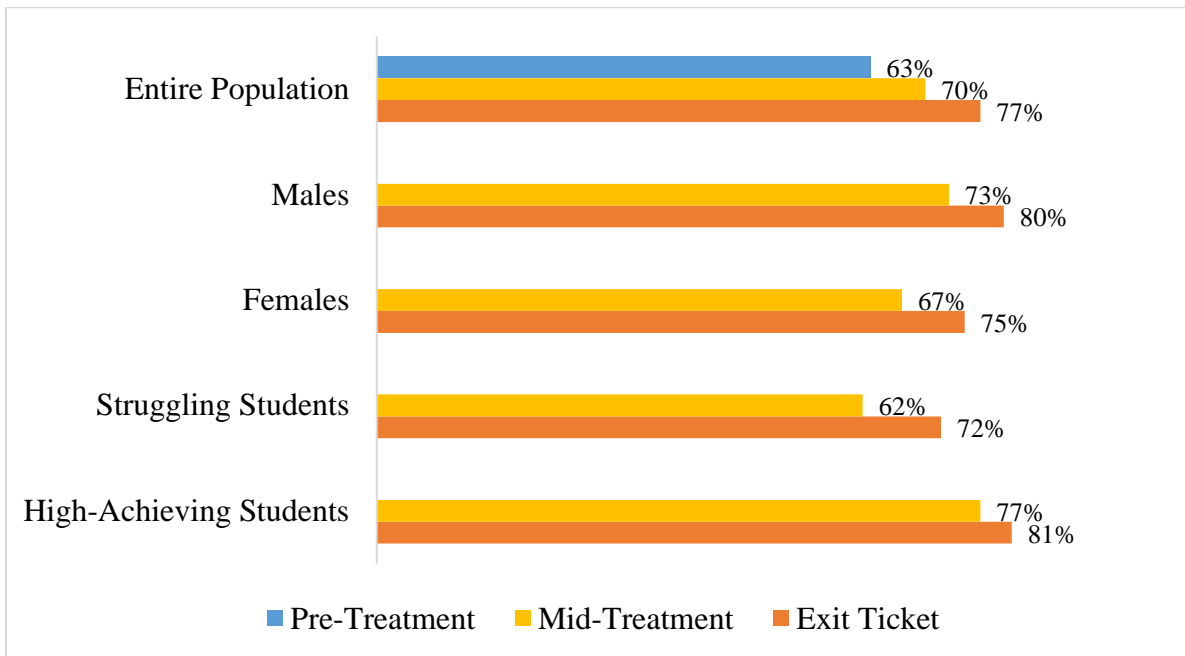


Figure 9. Students' preference for rankings in Kahoot!, ($N=100$).

During interviews and surveys most students said they preferred to see their points because as two interviewees stated, “I like it better with rankings, if there aren’t any it’s like playing a pointless game”, “I like rankings because it’s like bragging without bragging.” During the game the most enthusiastic students would shout out and ‘trash talk’ when they got an answer right or saw their name on the ranking board. Because of the obvious enthusiasm over scores, it was easy to overlook the 35% of the students that didn’t prefer Competitive Kahoot!. As previously mentioned, the mid-term surveys showed that 10% of the students preferred No-Score Kahoot! and 20% of the students preferred Team Kahoot!.

On the pre-treatment Likert survey 53% of the students said they tried harder because their scores were displayed publicly, but by the final Likert survey that percent had dropped to 46% even though the enthusiasm for ranking continued to increase (Figure 3).

Gender Preferences for Competition

Research suggests (Devonshire, et. al, 2014) that boys prefer competitive games more than girls do. The Mid-treatment survey results did not support that hypothesis (Figures 10, 11) and a chi-square test showed no statistical difference between male and female preference for rankings over no scores. The chi-square statistic was 0.5802 and the p-value was 0.44622 rendering the difference as not significant at $p < 0.05$.

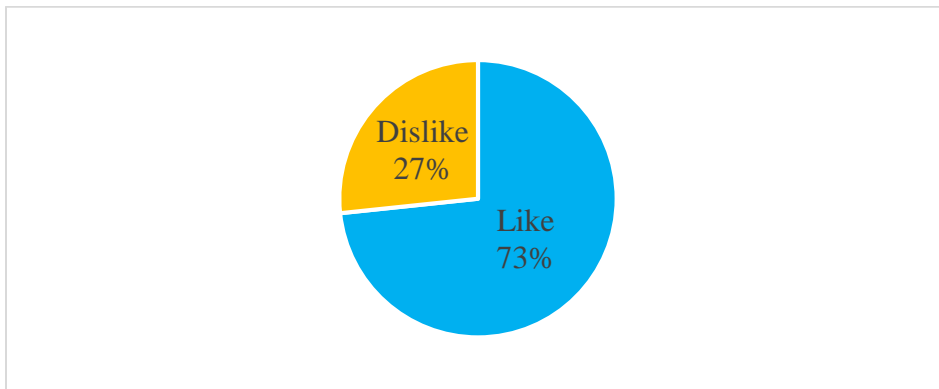


Figure 10. Mid-treatment, male students' preference for rankings, (N=50).

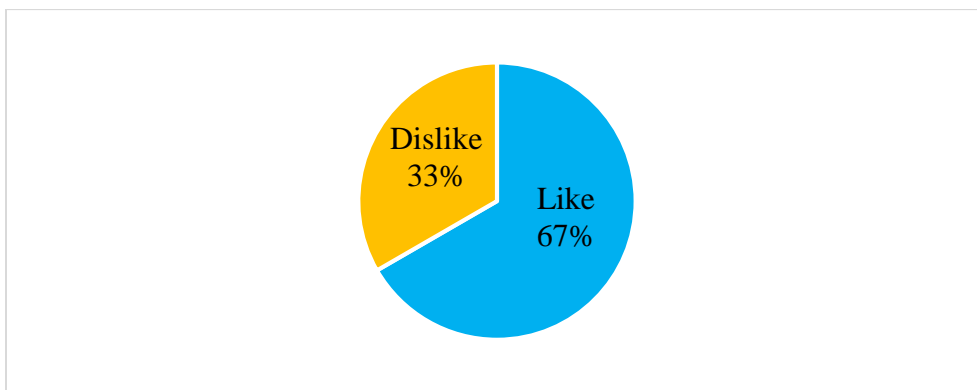


Figure 11. Mid-treatment, female students' preference for rankings, (N=55).

Twenty percent of the students admitted to being more interested in rankings than the content of the Kahoots!. On the Mid-Treatment survey approximately one-fourth of the students — 12 females and 15 males — said they were more interested in their scores than the answers to the Kahoot! questions (Figure 12). The female students were evenly split between academic abilities, but two-thirds of male students were low-performing students and disengaged from school. The other third of the males were very high-achieving and quietly-confident students. Many of the low-performing males are avid video game players and it could be they perceived Competitive Kahoot! as a simplified video game. Kahoot! is a way to engage these students even when they are not as interested in content because they are still reading the questions and receiving feedback on their understanding. Several of them reported they felt Kahoot! helped them learn because they remembered Kahoot! content when they saw it on a test.

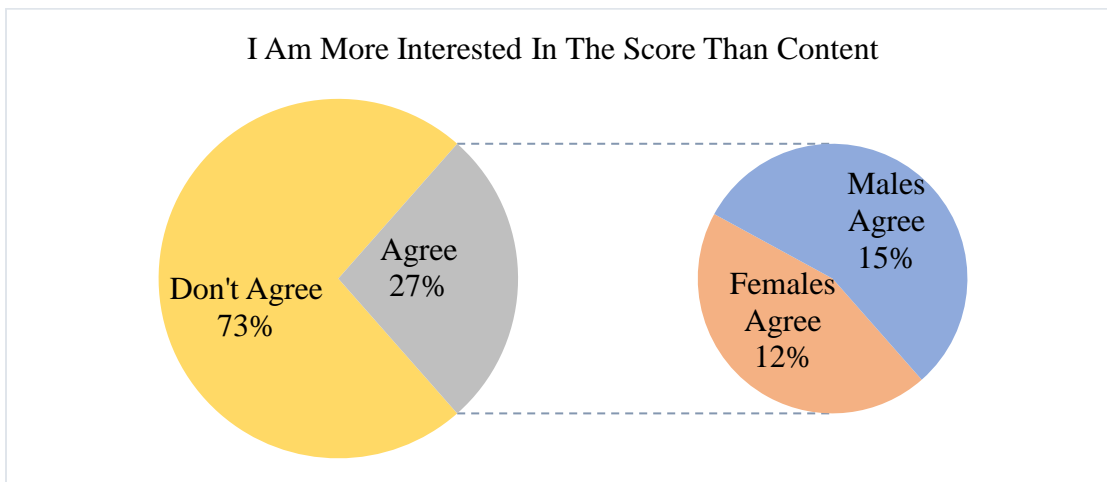


Figure 12. Mid-treatment survey, percent of students more focused on scores, ($N=100$).

High-Achieving Students' Preference for Competitive Kahoot!

Three-fourths of the high-achieving students preferred Competitive Kahoot!, with males showing the greatest preference at 88%, according to the Exit Ticket survey (Figure 13).

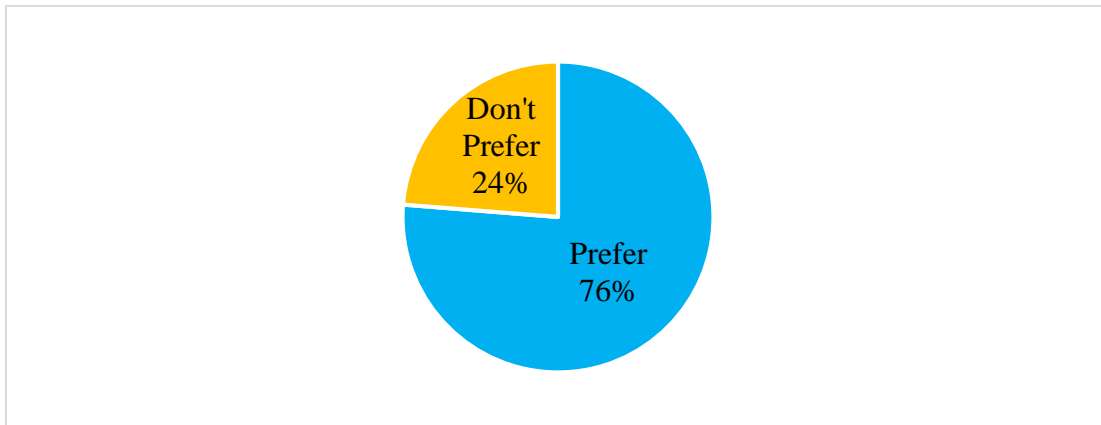


Figure 13. High-achieving students' final preference for Competitive Kahoot!, ($N=59$).

When high-achieving students were asked, on surveys and interviews, why they preferred rankings, common themes arose: the social and gaming aspect of ranking was fun, competition motivated them to try harder, and competing helped them see how well-prepared they were for assessments compared to their peers. Avery motivated, but socially uncomfortable, boy said, "Getting good scores makes me feel better about myself." Another high-achieving male turned it into a competition with friends,

I don't like it as much when there aren't any rankings because I have a competition with friends to see who can get the best rank. Also, there's more motivation. I like to see the rankings because it tells me if I need to work on the subject or not.

Other high-achieving males commented, "When I score really high it makes me less worried about the assessments" and "I feel like some people don't try without rankings. Rankings make Kahoot feel competitive and I like that."

High-achieving females had similar comments: “I like rankings because you actually work for something and get to see if you are better than someone.”, “I like the rankings because it pushes me to do better at the questions. It makes me want to get all answers right, so I can get 1st place”, and “When I score really high it makes me less worried about the assessments.”

High-achieving Students That Did Not Prefer Competitive Kahoot!

Although 75% of high-achieving students described the Kahoot! ranking system as motivating, there was a sub-group of high-achieving students that felt uncomfortable during Competitive Kahoot!. According to the mid-term survey and student interviews, high-ability but quiet and shy students did not like the public competition of Competitive Kahoot!.

It’s embarrassing when you get something wrong. It makes me tense and anxious and I try to stay calm on the outside. I don’t find them helpful or fun. They don’t really help me, but they do help some people. I can’t learn when I’m tense and anxious and that is how Kahoot! makes me feel.

Others responded, “I like it better when there aren’t rankings, so people don’t brag. I don’t like to hear people say what place they got,” or “It’s better without [rankings] because then people wouldn’t get mad or sad.” It is easy to overlook these students in a class of otherwise fiercely-competitive students.

Low-Performing Students’ Preference for Competition

A statistically significant difference in preferences for rankings was found between low-achieving students and high-achieving students by mid-treatment (41% of low-achieving and 75% of high-achieving). The difference was tested with chi-square test and the p-value was 0.006647 which is significant at $p < 0.05$. The difference decreased by the end of the

project when 72% of the low-achieving students and 81% of the high-achieving students chose Competitive Kahoot! or Team Kahoot! as their preferred treatment.

Low-performing students were split on their preference for Competitive Kahoot!. The mid-treatment survey showed that 59% of the low-performing students disliked Competitive Kahoot! but that number dropped to 50% by the end of the five-month study (Figure 14).

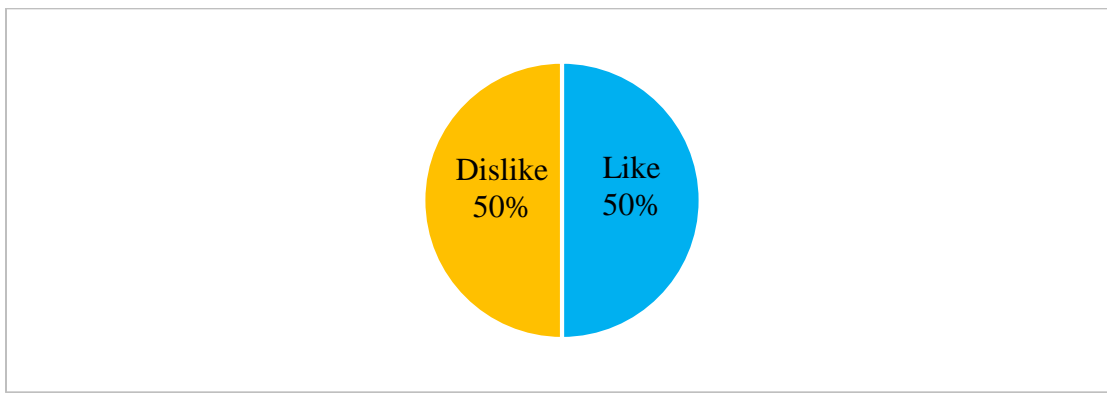


Figure 14. Struggling-students final preference for Competitive Kahoot!, ($N=46$).

Several unmotivated students said they liked Competitive Kahoot! because they did not try when there were no rankings, and the rankings pushed them to want to get the right answer. In an exit interview a male student explained why Competitive Kahoot! was especially good for students like his friend, an unmotivated special-education male that spent most of his time trying to sleep in class: “Kahoot! is easier for people like [him] because he doesn’t write but he likes points and is very competitive in video games.”

The low-achieving students that preferred to play No-Score Kahoot! said they were embarrassed by their score and were teased by other students; typical quotes were, “I prefer no ranking because it makes me feel not as smart as most people when I get a lower place,” or “I don’t like points because people rub it in when we get it wrong.”

Special Education Students' Preference for Competitive Kahoot! is Split

Twenty percent of my student population are special-education (SpEd) students, and surprisingly they were also almost split down the middle in their preference for competition (Figure 15). The SpEd students that liked Competitive Kahoot! enjoyed the gaming aspect, except for two that just liked seeing their name on the screen: Themes from interviews with SpEd students that did not like Competitive Kahoot! fell into three categories: social embarrassment, academic insecurity, and classroom disruption. Quotes included, “No, I don’t want ranking, so people don’t tease you on what you know,” “I prefer to play without rankings because there are a lot of hard questions,” and “No, because some people take them too seriously, and it gets too noisy.” When asked about the teasing it turned out that having other students around them celebrating and saying, “I got it right!” felt like teasing.

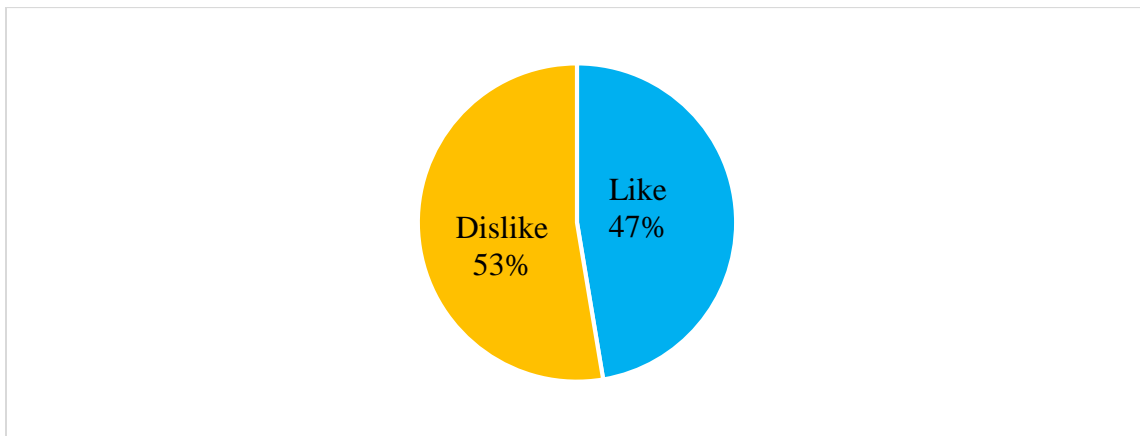


Figure 15. Special-education students mid-treatment preference for Competitive Kahoot!, (N=19).

Another difference between the SpEd students that liked Competitive Kahoot!, and the ones that didn’t, was social awareness. The special-education population seemed to be divided into two social groups: those that were socially unconcerned or unaware, and those that were socially-astute and more embarrassed by their academic struggles. Five of the SpEd

students were absent on the day of the survey, but of the 19 SpEd students that took the survey, nine blended in with the general population socially, and 10 seemed unconcerned with the social dynamics around them. Seventy-eight percent of the socially-aware SpEd students disliked Competitive Kahoot!, in contrast to 3% of the socially-unconcerned SpEd students.

Kahoot! as a Learning Tool

The third sub-question of this research project addresses the question of learning, “What is the effect of Kahoot! on students’ perception of their learning and on their summative test scores?” The instruments used to answer this question were two Likert surveys (pre- and post-research), three student interviews (pre-, mid- and post-research), a written, mid-research survey, eight unit-tests, and a delayed pop-quiz.

Students’ Perceptions of Their Learning

According to the pre- and post-research Likert surveys, the number of students that felt Kahoot! helped them learn increased from 64% to 73% during the research project. (Figure 3). Mid-term survey results show that highly-motivated, unmotivated, and low-performing students respond differently to the question, “Does Kahoot! help you learn, and how do you know?”

Highly-motivated students liked the feedback from the Kahoot! graphs. They used them as a guide to decide what to study, and it made them feel more confident because they usually did well. Quotes from high performing students fell into themes: “I note the ones that I miss and study them for the test,” “I like the discussions during Kahoot! because they help me understand better because I can see the answers and pictures,” “Kahoot! helps because if I

get a question wrong I know why,” “If we have played Kahoot! during that unit I am more comfortable when it's time for the test. On our last test we hadn't played Kahoot!. I worried to see what I got,” “It’s like a fun studying game, and the discussions after each question are super helpful.”

Unmotivated students liked the motivation Kahoot! gave them to engage and learn. In answer the question of how they knew Kahoot! helped them learn they wrote: “Because they make you want to think,” “Helps because on the test I don’t just look at the question and guess. I know it helps me learn because [during Kahoot!] you have to focus on the question and think but there is no pressure.”

All of the special-education students were sure Kahoot! helped them learn, and their quotes fell into two categories: confidence boost and memory triggers: “Because after Kahoot! I feel smarter,” “Because when you get the answer right it just pops inside.” It was interesting that the wrong answers stuck with the high-achieving students and the right answers stuck with the special-education students.

Test Scores of Entire Population

While most students felt Kahoot! helped them learn, statistical tests did not show any significant difference in overall student test scores (Figure 16).

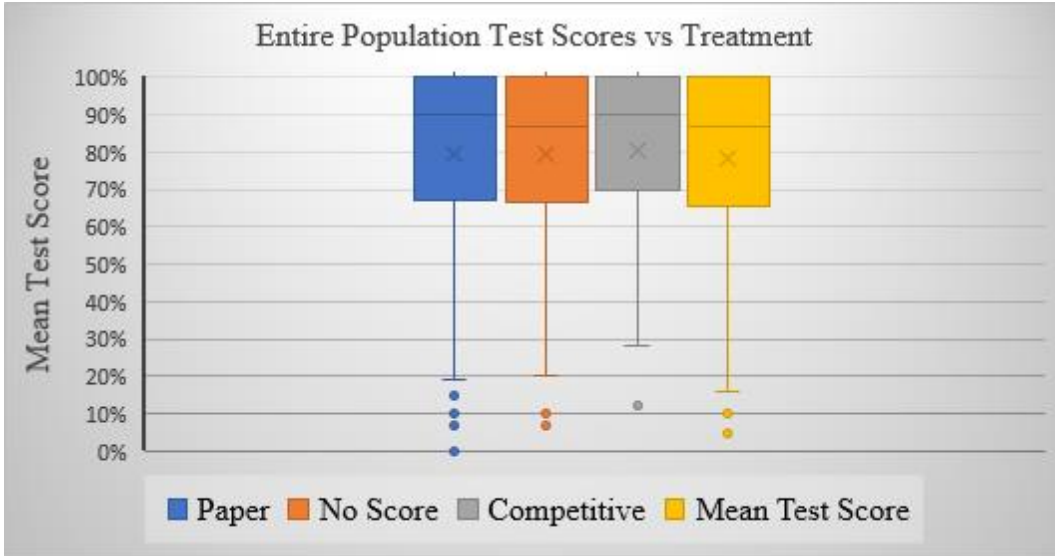


Figure 16. Means of the eight unit tests by treatment for entire population, (N=120).

Once again, separating the general student population into sub-groups based on learning ability, gender, and motivation revealed a greater difference in the range and distribution of the test scores (Figure 17).

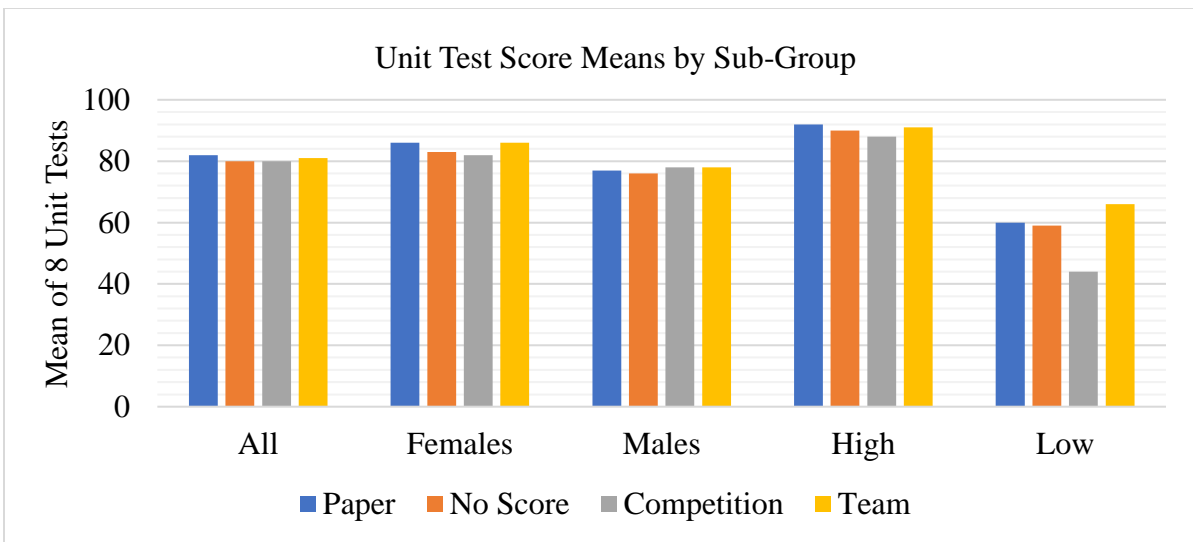


Figure 17. Test scores for all eight units divided by treatment and sub-groups, (N=120).

Struggling Students’ Test Scores Compared by Treatment

A compilation of the Competitive Kahoot! test scores by treatment shows negatively skewed results for the entire population of students (Figure 18), but when the test scores of

struggling students were pulled out of the whole they showed a distribution that was closer to normal (Figure 19). This was true for the results of all the treatments for struggling students (Appendix K).

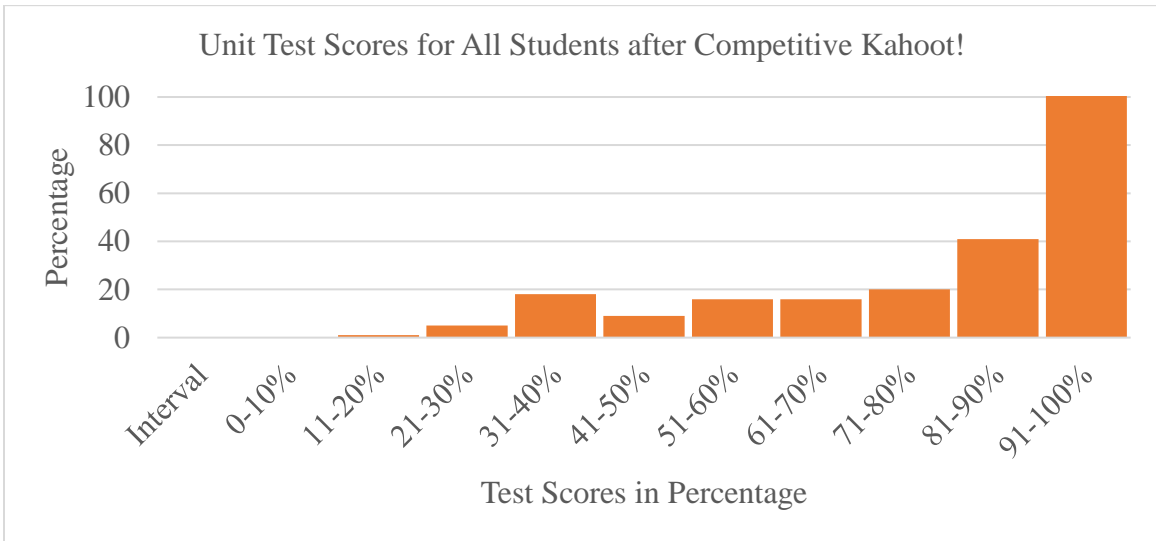


Figure 18. All students’ unit test scores after Competitive Kahoot!, (N=120).

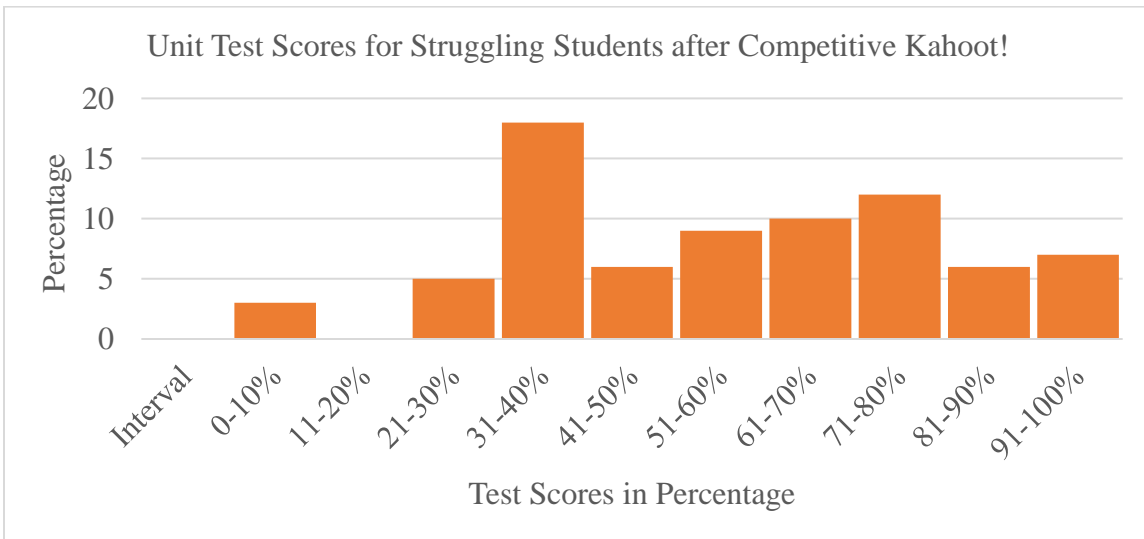


Figure 19. Struggling students’ unit test scores after Competitive Kahoot!, (N=43).

To get a better sense of the distribution of test scores for the struggling students, it helps to look at the range of scores that contain the mode. For the struggling population, the

majority of the Competitive Kahoot! test scores were significantly lower than their other treatment test scores (Table 3).

Table 3
Range of Struggling Students' Scores after Different Treatments

	Paper	No-Score Kahoot!	Competitive Kahoot!	Team Kahoot!
Mode Score Interval	71%-80%	71%-80%	31%-40%	51%-60%

Note. (N=46)

The mean test scores for struggling students was slightly lower after the Competitive Kahoot! treatment, and slightly higher after the Team Kahoot! treatment (Figure 20). This pattern also matched their treatment preferences at the beginning of the study. Possibly, their lack of confidence after the Competitive Kahoot! treatment, and their confidence boost after the Team Kahoot! treatment slightly affected some students test-taking abilities.

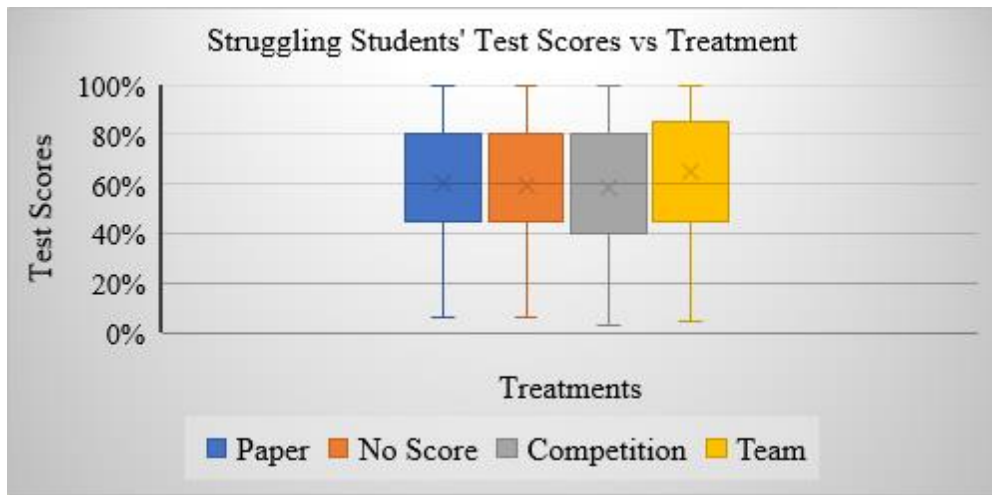


Figure 20. Mean of eight unit tests by treatment, struggling students, (N=43).

High-Achieving Students' Test Scores Compared by Treatment

High-achieving students' test scores did not vary like the struggling students did, although Competitive Kahoot! treatment seemed to tighten up the distribution of the high-achieving students' test scores (Figure 21).

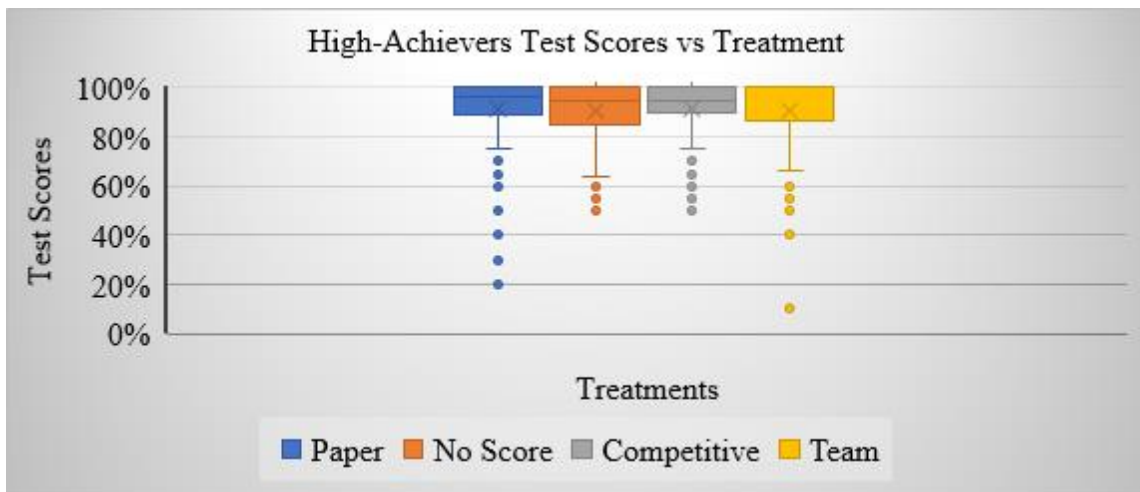


Figure 21. Mean of eight unit tests by treatment, high-achievers, ($N=54$).

Gender Differences in Test Scores and Treatment Preference

After every treatment the mean of the unit test scores for the female students were slightly higher than the male mean score, except after the Competitive Kahoot! treatment, in which they had very similar mean scores (Figures 22, 23).

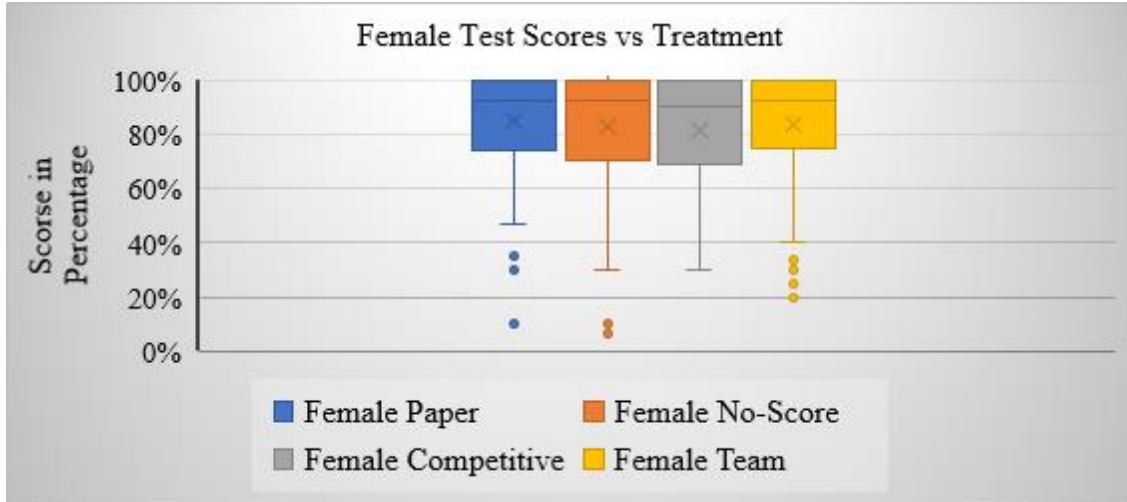


Figure 22. Mean of eight unit tests by treatment, females, ($N=59$).

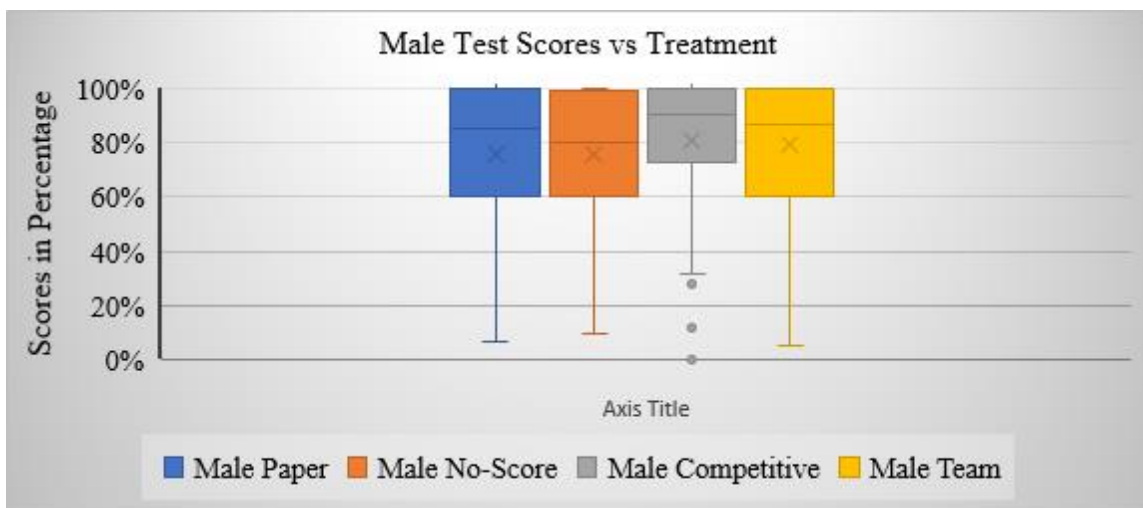


Figure 23. Mean of eight unit tests by treatment, males, ($N=61$).

Male students' scores also had a greater spread than the females'. Going out two standard deviations on all the test scores showed that most of the outliers for each treatment result were male. On the Paper treatment test scores 88% of the outliers were male, and on the Competitive Kahoot! 75% of the outliers were male. Most of my lowest students are attention-deficit males and it could be the Competitive Kahoot! scores were slightly higher because that treatment was able to help them focus. During an interview a very quiet, and

easily distracted male student said he knew Kahoot! helped him learn because it helped him focus.

Long-Term Retention as Measured by a Kahoot! Quiz

Seven months after the beginning of the project a short pop-quiz was given as a No-Score Kahoot!. The quiz contained two general questions from each unit. Although it was not a valid test of students' content retention, because the questions were not vetted and very limited in number, it was interesting to see that all the treatment means were within 2% of each other (66% to 68%) (Figure 24). Pre-tests showed that students came in without any previous knowledge of the science content that was covered during the eight units, so it was not surprising that the scores were low on this pop quiz, especially since some of the material had been covered 5 months prior to the pop quiz.

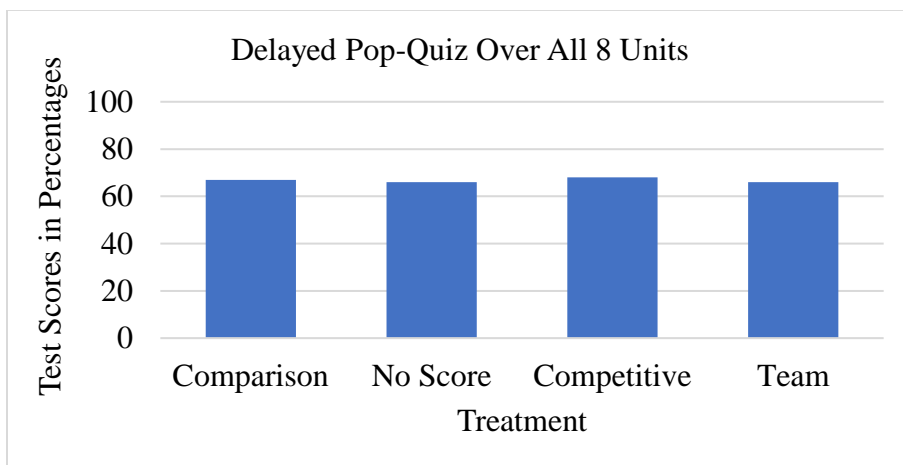


Figure 24. Comprehensive test scores after six months, ($N=109$).

INTERPRETATION AND CONCLUSION

The goal of this research project was to determine the value of using Kahoot! in its various forms, as a formative assessment in a seventh-grade science classroom.

Requirements of a Quality Formative Assessment

According to the Assessment Reform Group in the United Kingdom a quality formative assessment must include the following five elements (William, 2018):

Quality Formative Assessment Must Provide Effective Feedback to Students

Kahoot! does provides feedback in an engaging and playful way. The feedback is immediate, specific, and often addresses misconceptions if the teacher discusses the results between questions. At the end of this seven-month research project 87% of the students said they preferred to learn with Kahoot! over the traditional classroom discussion (Figure 1). I thought Kahoot!'s emphasis on play might cause students to place less importance on learning but, because it is so engaging, students always look up to read the questions and attempt to answer them as best they can. (Student response to learning questions)

Initially, Competitive Kahoot! intimidated the majority of struggling students, but after 4 months most students seemed to find the public competition and the timed responses less intimidating. The Exit Ticket Survey, given at 6 months showed 87% of all students preferred some form of Kahoot! over the traditional classroom discussion and quiz.

The different treatments did not significantly affect students' test scores compared to traditional instruction but that may have been because of my unconscious habit of adjusting my instruction as I learned from each treatment. Belatedly I realized I was prolonging lessons in every class if one class did not do well on a Kahoot!, or I would clear up a misconception in all my classes if one was discovered in a previous class.

Quality Formative Assessment Must Provide Feedback to the Teacher and Cause Adjustment to Instruction

Kahoot! is especially well-suited to provide teacher feedback because of the histograms that appear after each question/response cycle. I was able to immediately explain why a question was right or wrong and intentionally place misconceptions in the answers, so I could see if they had been cleared up. In the mid-term survey and student interviews many students mentioned that the teacher explanations were very useful in helping them understand why their choice was right or wrong (Figure 18). Kahoot! also stores the results of each Kahoot! online so it is easy to see how a specific student is answering the questions. On occasion I even asked students to turn their screens towards me, in the middle of a Kahoot!, so I could check for a specific students' understanding of the question that was just asked.

Unfortunately, as mentioned above, the ability to so easily adjust instruction may have compromised the test results of this research project.

Quality formative assessment must actively involve students in their own learning

This is one of the features of Kahoot! I like best, every student has a Chromebook and is actively reading questions and selecting answers, no student quietly zoning out. Observation results showed that at worst 24% of the students might cruise the internet or talk while waiting for the game to show responses, but when the question or graph goes up on the screen all eyes are looking up, and fingers are poised to click the response. No one is “zoning-out”. Literature on goal-making and learning makes a distinction between mastery goals and performance goals (Erhel & Jamet, 2013). Mastery goals create the desire to master new knowledge, performance goals create the desire to succeed, particularly by surpassing

others. My concern was that Competitive Kahoot! would cause students to focus on performance goals (ranks) and they would not learn as well. This is still unclear as test score means were not significantly different for each treatment (Figure 19). Many students mentioned ways in which they used Kahoot! feedback to help them study, and specific moments in which they realized they recognized information from a Kahoot! on a test, so Kahoot! may also help students with mastery goals and deeper learning. It certainly makes students aware of their own learning.

Quality Formative Assessment Must Allow Students to Assess Themselves and Understand How to Improve

Kahoot! certainly makes students aware of their own learning. They can see their rank during Competitive Kahoot! and Team Kahoot! so they have an idea as to how their understanding compares to the rest of the class and they can see the specific questions they do not understand. Because the feedback on the questions is specific, students are empowered to use this information to study for tests. When I used the same Kahoot! more than once in the same class, students' responses always improved, especially on questions that most missed the first time. High-achieving students mentioned this phenomenon in their interviews, commenting on how the questions they had missed the first time seemed to stick in their head. The effect may be just the opposite for students that do not get as many questions correct. One special-education student said, when reflecting on how Kahoot! helped him learn, "When you get the answer right it just pops inside [your head]."

Quality Formative Assessment Must Recognize the Influence Assessment Has on Students'

Motivation and Self-Esteem, Both of Which are Crucial Influences on Learning

I was concerned that Kahoot! would not help the motivation or self-esteem of all students, which is what led to the sub-question, “What is the impact of public competition on students of different genders and abilities?” This is still an area of concern, especially for the socially aware low-achieving students, and the quiet and serious high-achieving students. Most high-achieving students thrived on the competitive ranking system of Competitive Kahoot!, but not all students did. Competitive Kahoot! can be hard on struggling learners, especially in the beginning when ranks and competition are new, and more important. At the beginning of the study most struggling learners did not like the ranking and public display of correct and incorrect choices on their screens, and their comments and test scores (Figure 22) reflected that anxiety. “I prefer no ranking because it makes me feel not as smart as most people when I get a lower place,” or “I don’t like points because people rub it in when we get it wrong,” were some of their comments during student interviews. Initially, struggling learners preferred Team Kahoot! because they had the opportunity to talk over the answer with a peer before responding, and as two special-education boys pointed out, “I like teams because you both get to think and help each other,” and “I like teams because if your team wins you feel more happy.” The strongest reaction against Competitive Kahoot! came from the quiet and shy high-achieving students that also felt exposed by the public competition: “I don't like them because it's embarrassing when you get it wrong. I don't know why but I just hate it when people see my grades or see me get something wrong,” or “I like it better when there are not rankings cause it's less competitive and less stressful. Sometimes I don't care

about the rankings at all and I learn things.” By the end of the study students seemed more comfortable with the public competition and 65% of the students preferred Competitive Kahoot! to the other treatments (Figure 3).

One interesting note was the split in the special-education students. Socially-aware special-education students never preferred Competitive Kahoot!, but the socially-less-mature SpEd students enjoyed the gaming aspect of Competitive Kahoot! and were not as concerned with their peers’ perceptions of their intelligence.

VALUE

I will continue to use Kahoot! as a formative assessment because of its ability to engage the majority of my students in a playful way and its instant feedback to students and teacher. Spreadsheets of Kahoot! results show individual students’ answers and can be downloaded at any time, which is very valuable when differentiating student instruction. This project has also made me more aware of the impact my instructional methods can have on student’s emotions and engagement. Now when I design lessons, I am more likely to think about their impact on specific students than I would have before this research project.

The results of this classroom research study show that my original concern about the impact of Kahoot!’s public display of scores on struggling students was valid. This research also helped me notice the quieter students in my classroom and it led me to reflect on how the social differences between my special education students could affect their receptiveness to learning. Intuitively, I knew some special education students were more embarrassed by their inability to learn quickly, but I had not tied their reaction to their social status among peers until now. I would like to explore the ghost mode of Kahoot! that allows students to

play against themselves and track their progress as they play a Kahoot! multiple times. This might help mitigate the embarrassment for students that are not comfortable with the public display of scores, and keep the excitement generated by the ranking system. In the future, I will also be more careful in pairing students up for Team Kahoot! to ensure high-achieving students help their partners rather than exclude them during the Kahoot!.

My students had only played Kahoot! twice when I first surveyed them about their preference for Kahoot! over classroom discussions. Sixty three percent of them said the timing made them anxious (Figure 2) but 65% of them still preferred it over the usual classroom discussion. Mid-treatment, after two months of playing Kahoot! once or twice a week, enthusiasm for Kahoot! peaked with 92% of the students preferring Kahoot! over classroom discussions. By the end of the treatment that percent had dropped to 72%, but then it rose again after a month of not playing Kahoot! (Figure 1). I think this up and down trend may show that students do eventually tire of Kahoot! if it is played too often, and for too long. The exit ticket results showed that 87% of the students still liked some form of Kahoot! after six months so Kahoot! can engage students long-term. But playing Kahoot! twice a week was too often for me, it disrupted the flow of instruction and encouraged off-task behavior. Next year I would like to try a Kahoot! review every Friday. Students logged in before the bell if they knew we were going to be playing Kahoot! so having a structure to the Kahoot! schedule should make logging in quicker.

Kahoot! is ideally suited to vocabulary review because of its multiple-choice format and the graphics you can insert. It is also well suited to review basic content because all the students are involved and engaged so they are attentive when wrong answers are discussed,

and the immediate feedback allows the teacher to see how well prepared the students are for a test. It is especially useful as a test for misconceptions. Because of the brief time allotment and the multiple-choice format, it is more challenging to use Kahoot! to test for application and analysis skills, so it will not be my sole formative assessment.

Since students were using Kahoot! as a guide to help them decide what to study, I would like to match my class notes more closely to the Kahoot! questions so it is easier for students to know find the content that they missed on the Kahoot!. My Kahoot!s were tied to NGSS, but I would like to title them with the learning standards and post them on my website, so my students can play them at home to prepare for a test. This will also make my website a resource for other life-science teachers that want to use Kahoot! to teach NGSS standards. When Kahoot!s are made public they are downloadable to any computer and can be edited to fit any teacher's needs. A website devoted to Kahoot!s that specifically address a set of standards would be very useful to all teachers, especially new teachers that are strapped for time and are just learning how to create formative assessments. When I mentor new teachers, I hand them a notebook of curriculum I have developed, and I think a website of Kahoot!s would be a valuable addition.

Because of its success Kahoot! has attracted the attention of big investors, most notably Disney and Microsoft. Kahoot! announced that it would like to become a publisher of academic Kahoot!s with the help of Lucas Film, ESPN, and possibly established publishers like Pearson and McGraw Hill. Kahoot! began as an idea of a Norwegian professor, Alf Inge Wang, and his graduate students. In search of resources for this project I contacted professor Wang and he was gracious enough to share his work with me and asked

to see this project once it was completed. Possibly some of the results of this project will help future Kahoot! publishers in some small way.

The primary value of this project to me as a teacher was the increased amount of time I spent interviewing individual students. I have never spent so much time analyzing the needs of individual students and I have learned how valuable their feedback is to instruction. Next year I plan to embed student interviews into my curriculum.

A note of caution: Kahoot! made my classroom more fun and my instruction more responsive, but over time students' enthusiasm for science class dropped a couple of percentage points between the pre- and post- Likert survey. As Kahoot!s became a weekly, or bi-weekly event I began to feel a little bit like a game show host, and a little less like a teacher. Using Kahoot! too often disrupted the flow of instruction and without the give and take of classroom discussion I felt a disconnect from my students. Like any tool, Kahoot! can be overused, but this research study has convinced me that Kahoot! is a very valuable formative assessment because of its ability to engage students and inform instruction and learning.

REFERENCES CITED

- Dropout rates fluctuate in St. Helens, decline in Scappoose schools. (2016, October 14). Retrieved from <https://portlandtribune.com/scs/83-news/327290-206830>
- Abrahamson, L. (1999). *Teaching with a classroom communication system - what it involves and why it works*. Retrieved from bedu.com/Publications/PueblaFinal2.pdf:
- Bessler, W., Nisbet, J. (1971). The use of electronic response systems in teaching biology. *Science Education*, 55(3), 275-284.
- Black, P. J., Wiliam, D. (1998). *Inside the black box: Raising standards through classroom assessment*. London, UK: King's college London School of Education.
- Black, P. J., Wiliam, D. (2001). *Inside the Black Box*. Retrieved from London, UK:
- Carnegie, J. (2015). Use of Feedback-Oriented Online Exercises to Help Physiology Students Construct Well-Organized Answers to Short-Answer Questions. *CBE Life Sci Educ*, 14(3). doi:10.1187/cbe.14-08-0132
- Cleveland, L. M., Olimpo, J. T., & DeChenne-Peters, S. E. (2017). Investigating the Relationship between Instructors' Use of Active-Learning Strategies and Students' Conceptual Understanding and Affective Changes in Introductory Biology: A Comparison of Two Active-Learning Environments. *CBE - Life Sciences Education*, 16(2).
- Conoley, J. W., Croom, D. B., Moor, G., & Flowers, J. L. (2007). Using Electronic audience response systems in high school agriscience courses. *Agricultural Education*, 48(3), 67-77.
- Corbett, S. (2010, September 19, 2010). Learning by playing: video games in the classroom. *The New York Times Magazine*.
- Dudduan, C., Nirat, & Sumalee, C. (2015). Development of learning management model based on constructivist theory and reasoning strategies for enhancing the critical thinking of secondary students. *Educational Research and Reviews*, 10(16), 2324-2330. doi:10.5897/err2015.2193
- Erhel, S., & Jamet, E. (2013). Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers & Education*, 67, 156-167. doi:10.1016/j.compedu.2013.02.019
- Hwang, A., & Arbaugh, J. B. (2009). Seeking Feedback in Blended Learning: Competitive versus Cooperative Student Attitudes and Their Links to Learning Outcome. *Journal of Computer Assisted Learning*, 25(3), 280-293.

- Iverson, K. (2005). *E-learning games: interactive learning strategies for digital delivery*. Saddle River, NJ: Pearson/Prentice Hall.
- Jenkins, H. (2009). *Confronting the challenges of participatory culture: media education for the 21st century*. Cambridge, MA: MIT Press.
- Jong, M., Shang, Junjie, Lee, Jimmy. (2010). Constructivist Learning Through Computer Gaming. *ResearchGate*.
- Joyce, A., Gerhard, P., & Derby, M. (2009). How are digital games used in schools: Complete results of the study. *Computers & Education*, 44, 395-408.
- Kang, S. H. K., McDermott, K. B., & Roediger, H. L. (2007). Test format and corrective feedback modify the effect of testing on long-term retention. *European Journal of Cognitive Psychology*, 19(4-5), 528-558. doi:10.1080/09541440601056620
- Lane, J. (2011). *Gaming as an Educational Strategy to Enhance Clinical Judgment and Knowledge Retention*. ProQuest LLC, Retrieved from <http://search.ebscohost.com.proxybz.lib.montana.edu/login.aspx?direct=true&db=eric&AN=ED535882&site=ehost-live>
- http://gateway.proquest.com/openurl?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&res_dat=xri:pqdiss&rft_dat=xri:pqdiss:3481887 Available from EBSCOhost eric database.
- McDaniel, M. A., Agarwal, P. K., Huelser, B. J., McDermott, K. B., & Roediger, H. L. (2011). Test-enhanced learning in a middle school science classroom: The effects of quiz frequency and placement. *Journal of Educational Psychology*, 103(2), 399-414. doi:10.1037/a0021782
- McDaniel, M. A., Thomas, R. C., Agarwal, P. K., McDermott, K. B., & Roediger, H. L. (2013). Quizzing in Middle-School Science: Successful Transfer Performance on Classroom Exams. *Applied Cognitive Psychology*, 27(3), 360-372. doi:10.1002/acp.2914
- McDermott, K. B., Agarwal, P. K., D'Antonio, L., Roediger, H. L., 3rd, & McDaniel, M. A. (2014). Both multiple-choice and short-answer quizzes enhance later exam performance in middle and high school classes. *J Exp Psychol Appl*, 20(1), 3-21. doi:10.1037/xap0000004
- Nadrah, Tolla, I., Ali, M. S., & Muris. (2017). The Effect of Cooperative Learning Model of Teams Games Tournament (TGT) and Students' Motivation toward Physics Learning Outcome. *International Education Studies*, 10(2), 123-130.

- Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.
- Quinn, C. N. (2005). *Engaging learning: Designing e-learning simulation games*. San Francisco, CA: Pfeiffer/Wiley.
- Reisel, J. (2013). *Analysis of the impact of testing frequency on student performance in a basic thermodynamics course*. Retrieved from 2013 ASSEE Annual conference & Exposition:
- Roediger, H., Putnam, A., Smith, M. (2011). Ten Benefits of Testing and Their Applications to Educational Practice. *55*, 1-36. doi:10.1016/b978-0-12-387691-1.00001-6
- Rondon, S., Sassi, Fernanda, Furquim de Andrade, Claudia. (2013). Computer game-based and traditional learning method: a comparison regarding students' knowledge retention. *BMC Medical Education*, *13*(30).
- Roos, B., & Hamilton, D. (2005). Formative assessment: A cybernetic viewpoint. *Assessment in Education: Principles, Policy & Practice*, *12*(1), 7-20. doi:10.1080/0969594042000333887
- Slavin, R. (2014). Making Cooperative Learning Powerful. *Educational Leadership*, *72*(2), 22-26.
- Standards, C. o. C. F. f. t. N. K.-S. E. (2012). *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, D.C.: The National Academies Press.
- Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Boston, MA: Harvard University Press.
- Wang, A., Lieberoth, A. (2016). The Effect of Points and Audio on Concentration, Engagement, Enjoyment, Learning, Motivation, and Classroom Dynamics Using Kahoot! , 738-746.
- William, D. (2018). *Embedded Formative Assessment* (2nd ed.). Bloomington, Indiana: Solution Tree Press.
- Williams, J. B. (2006). Assertion-reason multiple-choice testing as a tool for deep learning: a qualitative analysis. *Assessment & Evaluation in Higher Education*, *31*(3), 287-301. doi:10.1080/02602930500352857

APPENDICES

APPENDIX A
SCHEDULE OF ACTION RESEARCH

Table 4
Treatment Schedule

Unit	Paper Formative Assessments	Non-competitive Kahoot	Competitive Individual Kahoot	Team Kahoot
Macromolecules 11/16	Periods 2	Period 6	Period 3	Period 5
Cell Transport 11/30	Period 3	Period 2	Period 5	Period 6
Photosynthesis/Respiration 12/13	Period 2	Period 3	Period 6	Period 5
Nutrient Cycles 1/11	Periods 6	Period 5	Period 2	Period 3
Mitosis 1/24	Period 5	Periods 3	Period 6	Period 2
Characteristics of Life 1/30	Period 6	Period 5	Period 2	Period 3
Science Inquiry 2/26	Period 2	Period 6	Period 3	Period 5
DNA/Protein Synthesis 3/9	Periods 3	Period 2	Period 5	Period 6

First Interview – 10/23-24/2017

First Survey – 10/27/2017

Began Treatment with Macromolecule Unit – 11/16/17

Second Interview and Survey – 1/17/2018

First Observation – 2/26/2018

Second Observation – 3/14/2018

Finished Treatment with the end of Protein Synthesis Unit Test – 3/16/17

Third Survey – 3/21/2018

Third Interview – 4/25/2018

Cumulative Review Kahoot! – 4/25/2018

APPENDIX B
DATA COLLECTION INSTRUMENTS

Table 5
Measurement Tools for Data Collection Instruments

DATA COLLECTION INSTRUMENTS	MEASUREMENT TOOLS
Comprehensive Test	Compare scores on the questions from each treatment
Pre/Mid/Post Student Interviews	Group by themes, gender, academic ability Collect quotes, note patterns
Unit Pre-/Post-tests	Mann-Whitney test, Normalized gains
Pre/Mid/Post Student Surveys	Chi-squared tests on Likert Surveys, tally and show on a split-bar graph
Formal Observations	Calculate student time on and off-task during different treatments
Informal Interviews	Record and collect quotes
Teacher Journal	Note observations and patterns, and collect quotes

APPENDIX C
STUDENT LIKERT SURVEY

Kahoot! Likert Survey

This survey was given after students were advised that their responses would not affect their grade, but they were important to the integrity of this research project. They were thanked for their participation and then the Kahoot! survey began. The answer choices were: Strongly Agree, Agree, Disagree, and Strongly Disagree.

Q1: I like seeing my score in Kahoot!

Q2: I prefer to take a paper quiz than a Kahoot! quiz.

Q3: I prefer to play Kahoot! without the scoring.

Q4: Seeing the correct answer right after responding helps me learn.

Q5: Kahoot! makes me anxious because it is timed.

Q6: I pay more attention during Kahoot than I do during classroom discussion.

Q7: I am more interested in my Kahoot! score than the answer to the question.

Q8: I would prefer to play Kahoot! without the teacher's explanations.

Q9: Kahoot! helps me learn more because it makes me pay attention to the answers.

Q10: Kahoot review questions help me do better on tests.

Q11: Science class is interesting.

Q12: I try harder on a Kahoot! quiz because people will see my score.

Q13: I prefer to take a paper quiz, than play Kahoot! so I can explain what I know.

Q14: I prefer to play Kahoot! as a team

Q15: I learn more when I can discuss the answer with a partner before selecting the answer.

Q16: During team Kahoot! I am less focused on the questions and more interested in socializing.

APPENDIX D
MID-TREATMENT STUDENT SURVEY

MID-TREATMENT STUDENT SURVEY

Thank you for helping me with my research. I am trying to improve my instruction to help my students learn as well as they can. The answers you give me are confidential and will not affect your grade, or my opinion of you, in any way. Thanks for your willingness to help.

Name _____ Period _____

1. What about school do you like or not like?
2. Did you enjoy science class last year?
3. Do you like science class this year?
 - a. What do you enjoy best about it?
 - b. Do you feel you are better or worse at science this year?
4. What part of science are you least comfortable with or do you like the least?
 - a. What about this activity do you not like?
5. What helps you learn best in class? You can use examples from this class or others. Examples - labs, lectures, hands-on, videos, read pair/share, notes, using notes to fill in worksheets, Kahoot?
6. Do you like playing Kahoot!? Please explain your answer.
7. Do you like it better when there aren't any rankings, just the graph, after each question? Please explain.
8. Do you prefer to see the rankings when playing Kahoot!? Please explain.
9. Do you like it better when you play it in a team?
10. Does knowing that we are going to play Kahoot! make you get ready for class sooner?
11. Is it hard to calm down after playing Kahoot!?
12. Does the music make you tense, or does it make the quiz more fun?

13. Would you like other teachers used Kahoot!?
14. Do the Kahoot quizzes help you learn?
 - a. Do they really help you learn, or are they just fun?
15. How do you know that they help you learn?
16. Are the discussions after each question helpful?
17. Are you more interested in the rankings or the answers to the quiz?
18. What do you think when you see the graph after each question?
19. What do you do with that information?
20. Do you prefer classroom discussions without Kahoot Better than discussions during Kahoot! quizzes? Please explain.
21. Is there something I can do to help you learn more easily, or enjoy science class more?
22. Can you think of something else that I should know about teaching or learning?

Thank you for taking the time to answer my questions.

APPENDIX E
STUDENT INTERVIEW QUESTIONS

Hi _____. Thank you for helping me with my research. I am trying to improve my instruction to help my students learn as well as they can. The answers you give me are confidential and will not affect your grade, but they will help me learn how to become a better teacher. Thanks for your willingness to help.

What do you like to do after school?

Do you study after school?

Watch TV, cruise the internet, play video games?

Do you look up science facts?

Did you enjoy science class last year?

What did you enjoy best about it?

Do you feel you are better or worse at science this year?

How often do you study?

Do you study because someone makes you, or because choose to?

Why do you study?

Can you think of a class that you really studied in? What can you tell me about that class and how you studied?

Do you study alone or with someone else?

Who do you study with?

When do you study?

How do they know when you've learned the material?

When do you stop studying? How do you know when you understand the material?

What helps you learn best in class?

Labs, lectures, hands-on, videos, read pair/share, notes, using notes to fill in worksheets?

Do you like learning on a computer? Why or why not?

Do you like playing Kahoot?

Do the Kahoot quizzes help you learn?

Do they really help you learn, or are they just fun?

How do you know that they help you learn?

Are you more interested in the rankings or the answers to the quiz?

Do you like it better when there aren't any rankings?

Are the discussions after each question helpful?

Do they make you sit down and log in before the bell rings?

Is it hard to calm down after playing Kahoot?

Does the music make you tense, or does it make the quiz more fun?

How do you feel about Team Kahoot!?

Do you prefer No-Score Kahoot!?

Have other teachers used Kahoot?

Do classroom discussions help you learn?

How do you know that they help you learn?

Do you prefer classroom discussions over Kahoot quizzes?

Do exit tickets help you remember what the lesson was about?

Is there something I can do to help you learn more easily, or enjoy science class more?

Thank you for taking the time to answer my questions. I will be interviewing you three times during this research project and the questions will remain about the same.

APPENDIX F
OBSERVATION INSTRUMENTS

Charles Darwin University School of Education Recording Sheet for Student Engagement

OBSERVING STUDENT ENGAGEMENT**Purpose and Focus of Observation**

Student engagement on worthwhile tasks has long been identified in research as a key element of effective learning and teaching. Sometimes preservice teachers, intent on their own 'performance' as teachers in classrooms, are not aware of the level of academic engagement of all learners. The following tool is a simple way to record apparent engagement of a selected group of students. Video-recording is particularly useful for this observation as well, especially if observer and observed watch the video together and share perceptions.

DIRECTIONS FOR OBSERVING STUDENT ON-TASK AND OFF-TASK BEHAVIOUR

Preservice teacher and school-based teacher educator should discuss ways of knowing when a student is on task, and discuss other student behaviours they may choose to code observe, e.g.

- A = at task
- AT = at task with teacher
- TK = talking
- P = playing
- O = out of seat
- OR = out of room
- OT = off task

Negotiate a time and duration for observation a short period of time is recommended – maybe 10 minutes.

Decide which students will be targeted for observation, and discuss reasons for choosing these children. It may be useful to do this several times, targeting 'noisy' learners, then 'good' workers, then 'quiet' learners, ect. (choosing only about 5 or students is recommended).

List students' names according to their seating arrangement.

Observer sits at side of room where all students can be observed, scans targeted students at 5 minute intervals, records student behaviour.

Sample of observed behaviours:

STUDENT	TIME							
	9:00	9:05	9:10	9:15	9:20	9:25	9:30	9:35
Lena	A	A	AT	A	A	A	OR	A
Manuel	A	A	AT	AT	A	OR	A	A
Vivian	AT	TK	TK	AT	AT	TK	AT	TK
Nunt	O	O	P	P	OT	O	O	OT
Joseph	OT	OT	AT	P	A	A	P	P
Michael	OT	OT	AT	P	O	AT	A	TK

1. Summary of discussion with Mentor Teacher (Preservice teacher to note)

--

2. Preservice teacher personal reflection.

--

(Spacing adjusted to fit the page)

Kahoot! Project Observing Student Engagement

Observer _____ Teacher _____ Period ____ Kahoot! Mode C TC NS None

Note student behavior before, during and after Kahoot by placing the observed code in each box. Any quotes or comments can be added under notes.

CODES

AU = at task looking up

AC = at task looking at chrome book

AO = at task other

TT = talking on task

TO = talking off task

TS = talking about score

OS = out of seat

OP = off task playing - on computer, or bothering another student

OT = other off task

Observer sits at side of room where all students can be observed, scans targeted students before, twice during, and after Kahoot.

STUDENT	TIME WHEN SWEEP BEGAN						
	Sign In	First 5 Questions	First 5 Graphs Teacher Explanation	Second 5 Questions	Second 5 Graphs Teacher Explanation	End of Kahoot	Logging Off Beginning Instruction
Summary of discussion between observer and teacher.							
Observer's personal reflection.							

APPENDIX G
DELAYED CUMULATIVE QUIZ

Questions from the Cumulative Kahoot! Quiz

- Q1:** Carbon, nitrogen, and water are (constantly recycled and reused)
30 se
- Q2:** Nitrogen is removed from the atmosphere primarily (by bacteria and plants)
30 se
- Q3:** All living things (are made up of cells)
30 se
- Q4:** Which is NOT a characteristic of life? (the ability to breathe)
30 se
- Q5:** The most common elements in living things are (carbon, hydrogen, oxygen)
30 se
- Q6:** What is the function of carbohydrates? (fast energy)
30 se
- Q7:** The scientific method always starts with a (question)
30 se
- Q8:** You pop 1337 kernels each of yellow and white popcorn and count them. (This is collecting data)
60 se
- Q9:** Cells divide in a process called (mitosis)
20 se
- Q10:** What typically occurs during the cell cycle of cancerous cells? (cell division is uncontrolled)
30 se
- Q11:** Sun energy is captured to make a glucose molecule during which process? (photosynthesis)
30 se
- Q12:** Respiration occurs (in both animals and plants)
30 se
- Q13:** What does this diagram represent? (exocytosis)
30 se
- Q14:** Water crosses a membrane through (diffusion)
30 se
- Q15:** This is a drawing of (protein synthesis)

APPENDIX H
EXIT TICKET SURVEY

Table 6
Exit Ticket Survey Results of Students' Treatment Preferences One Month after Project

Sub-Group	Paper	No-Score Kahoot	Competitive Kahoot	Team Kahoot
High-Achieving Boys N=24	12.5%	0.0%	87.5%	0.0%
High-Achieving Girls N=35	8.6%	14.2%	68.6%	8.6%
Low-Achieving Boys N=26	15.4%	11.5%	50.0%	23.1%
Low-Achieving Girls N=20	20.0%	10.0%	50.0%	20.0%
Entire Population N=105	13.0%	10.0%	65.0%	12.0%

APPENDIX I

REASONING FOR EACH INSTRUMENT

Table 7
Data Collection Matrix

DATA COLLECTION MATRIX TIED TO RESEARCH QUESTIONS	DATA COLLECTION METHODOLOGIES						
	Pre/Mid/Post Student Interviews	Pre/Mid/Post/Delayed Student Surveys	Pre-/Post-Unit Tests	Kahoot! Quiz Results	Observations	Delayed Comprehensive Quiz	Teacher Journal
Number of Repetitions for Each Class	4	3	8	16	2	1	1
Main Topic <i>What is the impact of using Kahoot! as a formative assessment in a science classroom?</i>	✓	✓	✓	✓	✓	✓	✓
Sub-question #1 <i>“What is the effect of Kahoot! on student engagement and performance?”</i>	✓	✓			✓		✓
Sub-question #2 <i>“What is the impact of competition on students of different genders and academic abilities”?</i>	✓	✓	✓	✓	✓	✓	✓
Sub-question #3 <i>“What is the impact on the teacher and instruction when Kahoot! is used as regular formative assessment?”</i>	✓	✓		✓	✓		✓

Reasoning for data collection tool

Pre/Mid/Post-Student Interviews – Collected qualitative data on the impact of Kahoot! on student’s opinions, attitudes, engagement, and impression of learning.

Pre/Mid/Post/Delayed-Student Surveys – Collected quantitative and qualitative data on the impact of Kahoot! on student’s opinions, attitude, engagement, and impression of learning.

Pre/Post-Unit Tests – Collected quantitative data on the change in student’s content knowledge and included written and selected-response answers.

Kahoot! Quizzes – Collected quantitative data to show the detailed change in student’s content knowledge and was used as a formative assessment.

Observations - Collected quantitative data on student’s engagement during Kahoot! quizzes.


Delayed Comprehensive Quiz - Collected quantitative data that measured student’s long-term retention of content knowledge through selected-response questions.

Teacher’s Journal - Collected qualitative data that reflected impact of the action research on teacher

APPENDIX J

IRB FORMS

ST. HELENS MIDDLE SCHOOL



TROJANS

MSSE IRB Administrator Approval Form

I, Linda Hall, Principal of St. Helens Middle School, verify that I approve of the classroom research conducted by Alison Charbonneau, a science teacher at our school.

Linda Hall, principal
 (Signed Name, Title of Position)
Linda Hall
 (Printed Name)
11/28/17
 (Date)

MSSE IRB Administrator Exemption Regarding Informed Consent

I, Linda Hall, Principal of St. Helens Middle School, verify that the classroom research conducted by Alison Charbonneau is in accordance with established or commonly accepted educational settings involving normal educational practices and that I approve the project. To maintain the established culture of our school and not cause disruption to our school climate I have granted an exemption to Alison Charbonneau regarding informed consent.

Linda Hall, principal
 (Signed Name, Title of Position)
Linda Hall
 (Printed Name)
11/28/17
 (Date)

Linda Hall Principal lhah@sthelens.k12.or.us	354 N. 15 th St. St. Helens, OR 97051 Phone: (503) 366-7300 • Fax: (503) 366-7306	Mark Jaska Dean of Students mark@sthelens.k12.or.us
--	--	---





Completion Date 12-Feb-2017
 Expiration Date 12-Feb-2020
 Record ID 22280749

This is to certify that:

Alison Charbonneau

Has completed the following CITI Program course:

Students (Curriculum Group)
Students - Class projects (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Montana State University

CITI

Verify at www.citiprogram.org/verify?wd794d2d7-4347-44fa-931b-56d58e099b79-22280749



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 0000165

960 Technology Blvd. Room 127
 c/o Microbiology & Immunology
 Montana State University
 Bozeman, MT 59718
 Telephone: 406-994-6783
 FAX: 406-994-4303
 E-mail: cherylj@montana.edu

Chair: Mark Quinn
 406-994-4707
 mquinn@montana.edu
Administrator:
 Cheryl Johnson
 406-994-4706
 cherylj@montana.edu

MEMORANDUM

TO: Alison Charbonneau and Walt Woolbaugh

FROM: Mark Quinn *Mark Quinn CJ*
 Chair, Institutional Review Board for the Protection of Human Subjects

DATE: November 29, 2017

RE: "The Effectiveness of Different Kahoot! Modes as Formative Assessments" [AC112917-EX]

The above research, described in your submission of November 29, 2017, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX K
COMPARISON OF TEST SCORE DISTRIBUTIONS

Table 8
Distribution of Test Scores by Sub-Groups

ALL STUDENTS' TEST SCORES, N=120	STRUGGLING-STUDENTS' SCORES, N=43
Paper Treatment	
<p>Frequency</p> <p>Interval</p> <p>Test Score in Percentage</p>	<p>Frequency</p> <p>Interval</p> <p>Test Scores in Percentage</p>
No-Score Kahoot! Treatment	
<p>Frequency</p> <p>Interval</p> <p>Test Score in Percentage</p>	<p>Frequency</p> <p>Interval</p> <p>Test Scores in Percentage</p>
Competitive Kahoot! Treatment	
<p>Frequency</p> <p>Interval</p> <p>Test Scores in Percentage</p>	<p>Frequency</p> <p>Interval</p> <p>Test Scores in Percentage</p>
Team Kahoot! Treatment	
<p>Frequency</p> <p>Interval</p> <p>Test Score in Percentage</p>	<p>Frequency</p> <p>Interval</p> <p>Test Scores in Percentage</p>